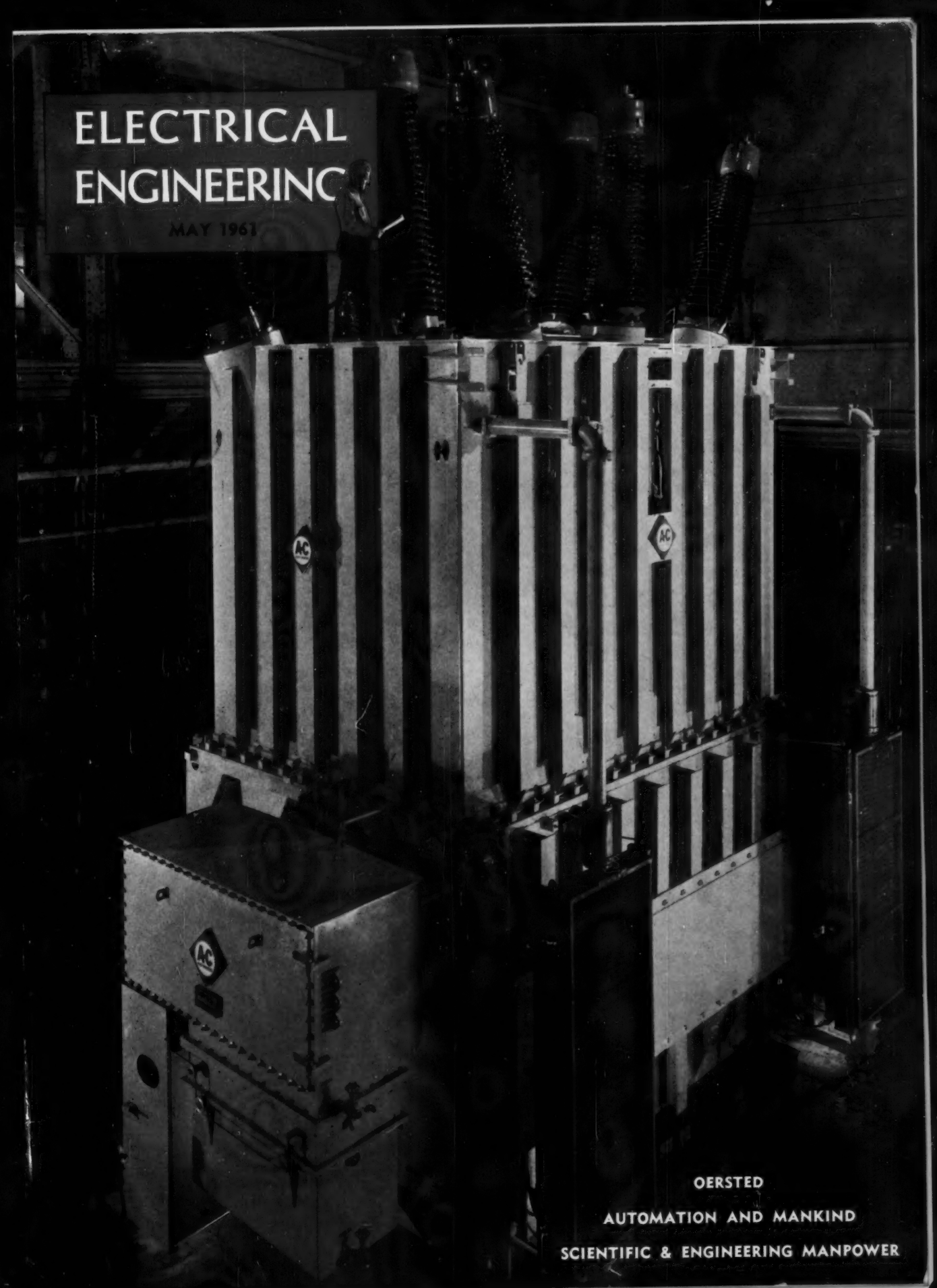
ELECTRICAL ENGINEERING

MAY 1961



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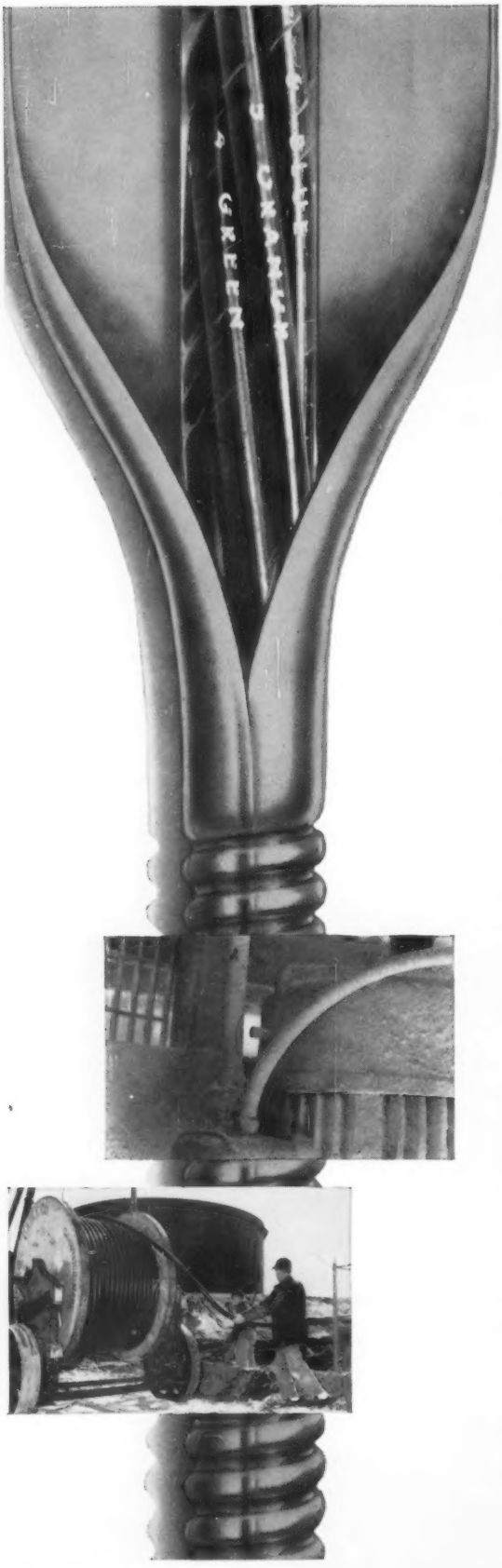
SCIENTIFIC & ENGINEERING MANPOWER



Only C-L-X®

Continuous Lightweight eXterior

Sealed Cable Systems by Simplex Can do so Many Jobs so Well

Simplex C-L-X is a packaged combination of cable and an extremely pliable, corrugated metal sheath. It requires no separate duct or conduit regardless of environment. It is available with steel sheath and plastic jacketing; and with copper or aluminum sheaths, with or without plastic jacketing.

C-L-X Cuts Installation Costs

By using a single length of 3-conductor 15KV C-L-X for both underground and aerial use, a Southeastern utility company saved more than 20,000 dollars from what it would have cost for a complete underground duct system.

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Protects Against Liquids and Gases

An East Coast petroleum tank farm used a C-L-X 8-conductor cable protected with PVC for direct burial in ground that was saturated with oil, gas and water. Result: Perfect performance at a sizeable savings over conduit systems.

Only Simplex C-L-X offers you: Exceptional Strength . . . Unequalled Pliability . . . Protection from Liquids and Gases . . . Faster Installation and Lower Costs. Send for Illustrated Brochure containing Application and Engineering Data.

SIMPLEX WIRE & CABLE Co

CAMBRIDGE, MASSACHUSETTS

ELECTRICAL ENGINEERING

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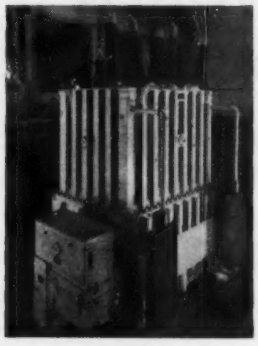

THE COVER: Scheduled for second-quarter installation at the Niagara switchyard of the Power Authority of the State of New York is this first of two huge load tap changing autotransformers—largest (in physical size) ever built by Allis-Chalmers Manufacturing Company. Story on p. 396.

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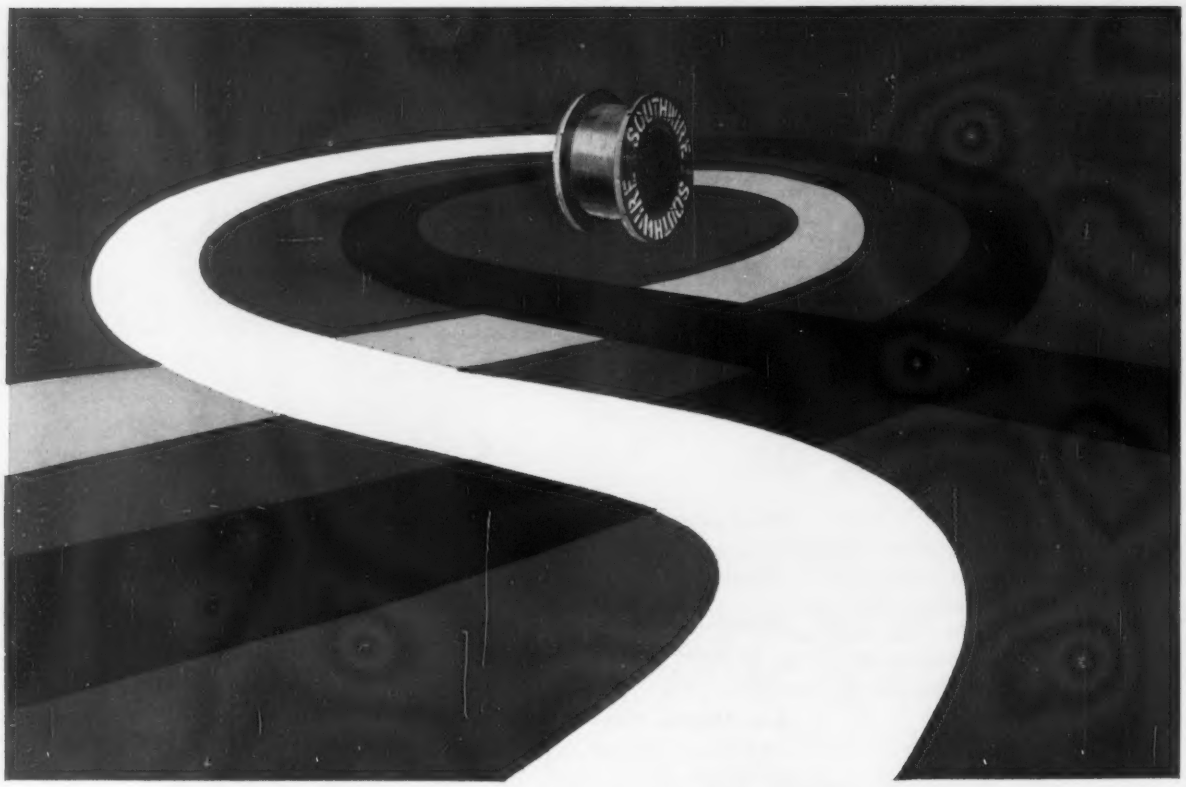

YOU CAN'T WAIT FOR THE WORLD TO BEAT A PATH THESE DAYS

"If a man can make a better mousetrap than his neighbor, though he builds his house in the woods, the world will make a beaten path to his door."

With respect to Ralph Waldo Emerson, competition being what it is in the twentieth century, Southwire has pressed his advice a step further. We have not only endeavored to make better products, but we have also succeeded in . . .

- Operating the industry's largest fleet of trucks for fast delivery to customers' warehouses and jobsites.
- Maintaining flexible manufacturing schedules to meet needs of customers on short notice.
- Pioneering continuous aluminum casting.
- Developing the first 11,000-pound coil of aluminum rod.
- Developing new products through basic research—including 100% free-stripping Neoprene.
- Acquiring a list of loyal customers, of whom we are justly proud.

That our customers have benefited from these achievements is borne out of their use of Southwire products and the consequent growth of our company, which is 25 times larger today than ten years ago.

Specify Southwire and we'll beat a path to your *door.*

Southwire Company

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SOUTHWIRE serves the world

Carrollton, Georgia — TErrace 2-6311

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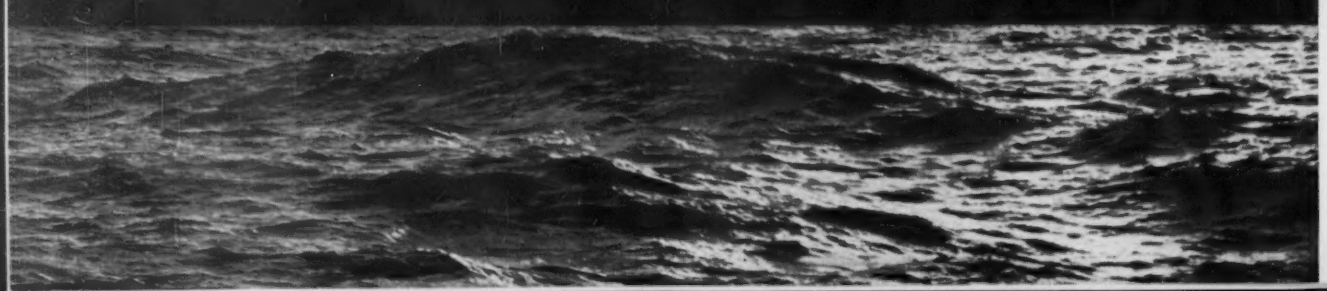
WATCH THIS SPACE

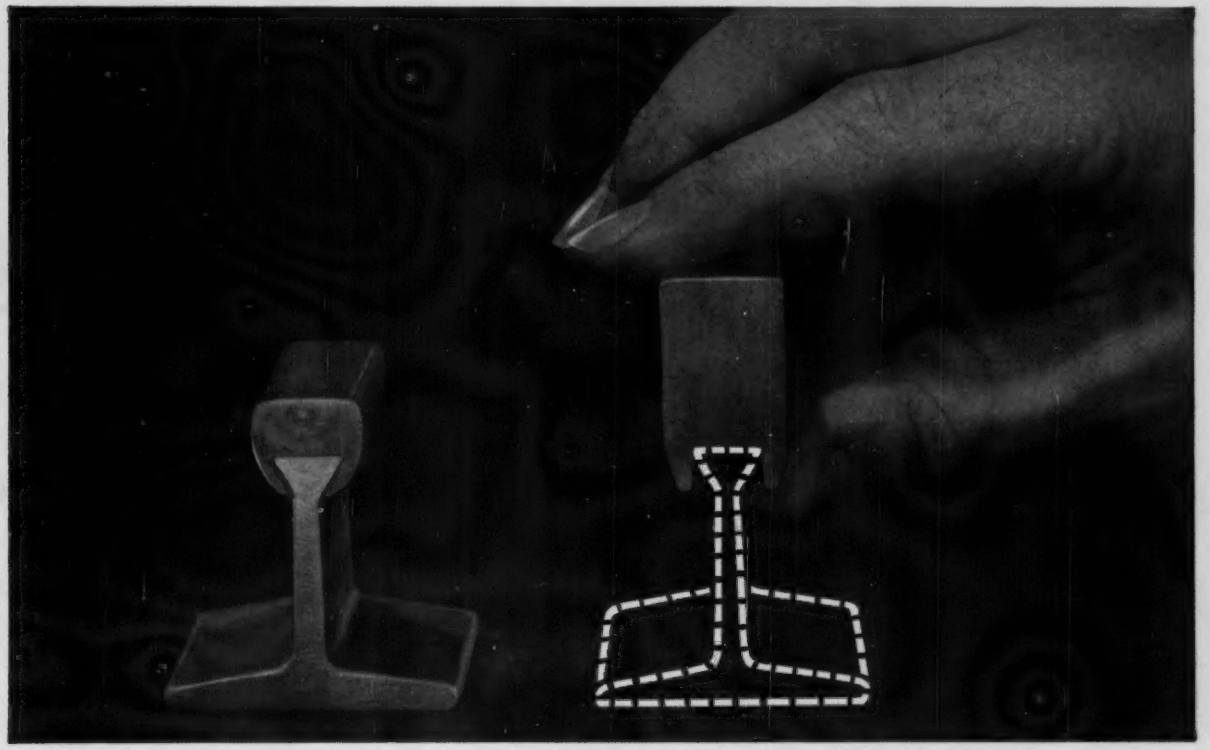
In a moment a new satellite will streak into view. Bell Laboratories may help guide it into orbit, for few are so eminently qualified in the science of missile guidance. Bell Laboratories' Command Guidance System has guided such trailblazers as Tiros and Echo into precise orbits. The same system will guide more new satellites into predetermined orbits as Bell Laboratories continues pioneering in outer space to improve communications on earth.

BELL TELEPHONE LABORATORIES

World center of communications research and development



COPPER FOR CONDUCTIVITY TEAMS UP WITH STEEL FOR STRENGTH



...in a compact, low-maintenance conductor system for heavy-current industrial applications

The copper-headed steel conductor rails, shown above, of the Ringsdorff Carbon Corp., East McKeesport, Pa., help provide many economies in conductor systems for such heavy-current users as traveling cranes, ore bridges, monorails—using either a-c or d-c.

The heart of the Ringsdorff Current Conductor System—the copper-headed steel conductor rail and pantograph current collector with a graphite carbon shoe. Components, including rail hangers and joints, are available in a wide variety of sizes, with capacities up to 2000 amps, for either a-c or d-c systems.

The system is simple and compact. One basic steel shape provides strength and simplifies installation. Over it is cold drawn the copper head of extruded Anaconda ETP Copper-100, in the size to meet individual current requirements. (Copper-headed conductor rail, left, 500 amps; right, 1500 amps.) Less space is needed; installation is easier than with aluminum rails.

Long life and low maintenance. The special Ringsdorff carbon graphite used in sliding contacts has an affinity to copper, putting down a film that lubricates its passage and protects the rails. Wear on the copper head is negligible over periods of 20 to 25 years. Only maintenance is replacement of carbon shoes, having an average life up to 3 years. Aluminum rails must be protected by lubrication or they will wear and pit—when out of use for a period may develop an insulating oxide film.

This is another illustration of the way the unique properties of copper are being utilized in industry to do things better—at lower cost. Anaconda has teams of specialists available to sit down with members of your organization to help select the alloys and forms of metal to solve your value analysis problems. For such technical help, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 6147

ANACONDA®

COPPER BRASS BRONZE NICKEL SILVER MILL PRODUCTS

Anaconda American Brass Company

WHO ELSE BUT CUTLER-HAMMER GIVES YOU ALL THESE FEATURES?

- Quick and safe maintenance
- All front connections.
- Tough baked enamel finish
- Completely safe wiring troughs
- Add options . . . no crowding
- Vertical bus silver plated
- Quick latch door fasteners
- Five padlock locations
- 100% interchangeability
- Positive off-power test position
- Modular construction

CONTROL

Now! Cutler-Hammer Unitrol in two new shallow depths!

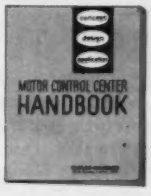
Get more compactness, more flexibility in motor control centers plus Cutler-Hammer dependability and safety

With Unitrol, you eliminate the high cost of mounting and wiring individual starters, as well as using far less space. Unitrol gives you flexibility, too . . . easy to change starters to fit needs and expand without disturbing other starter units. The two new shallow depths (15″ and 12″) make Unitrol practical even on catwalks or tunnels. Unitrol's modular design lets you put as many as 8 Size 1 starters in a single section and still leave room for many options.

But, probably more important is the safety factor built into Unitrol—safety for the men and machines. For instance, you can *lock* each unit in maintenance position for complete safety. Look at the features at the left for some of the extra values in Unitrol.

What's new at Cutler-Hammer? You can see the new spirit and vitality in a flood of new products and product improvements. Plant capacity has been increased. We've added new engineering talent to increase efficiency. Everywhere you look, you can see that we're ready to help you meet the challenge of the years ahead. Get the inside story from the Cutler-Hammer sales office nearest you.

NEW! FREE! BOOKLET: The "Motor Control Center Handbook" gives you practical facts on selecting the proper control as well as estimating for future needs. Send for Pub. LJ-1-J228 now!



WHAT'S NEW? ASK...

CUTLER-HAMMER

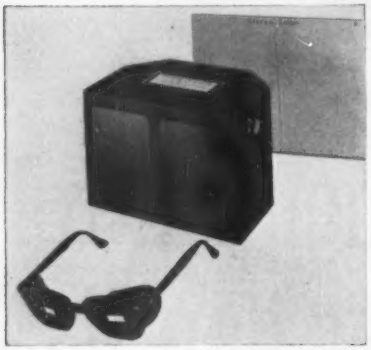
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

CONTROL

New and Improved Products . . .

3-Dimensional TV . . .

A stereo-television kit which optically converts any industrial television to 3-dimensional capabilities consists



of the Stereo-Captor that fits on the camera lens, a stereo screen positioned in front of the monitor, and stereo glasses. Installation requires only a few minutes while the change from a 2- to 3-dimensional effect may be accomplished in 4 seconds. Fidelity of depth perception, low cost, and simplicity of design and operation are the main features of this system. *Stereotronics Corp., 1717 N. Highland Ave., Los Angeles, Calif.*

Improved Bushing Oil Gage . . .

A new type of long-life ceramic magnet is now being used to indicate oil levels in the POC and POC-A line of ASA 15- to 196-kv standard bushings. These magnets, one geared to the float inside the oil reservoir, the other outside to give a corresponding dial reading, will not become demagnetized even under the heaviest stress of current or short-circuit surges. Unlike Alnico, which tends to demagnetize under these conditions, those made of ceramic metal (cermet) can withstand surges of over 100,000 amperes without loss of magnetism. *Lapp Insulator Co., Inc., LeRoy, N.Y.*

Machine Efficiency Recorder . . .

This device records and displays graphically the production status of any number of machines minute-by-minute throughout the day. Called the K-Logger, it shows the number of pieces—feet, pounds, gallons, etc.—produced since the beginning of the shift of day; the rate at which they were produced each minute in relation to what is normal for that machine; when down time occurred, and how long it lasted. Causes for down time, such as "set-up," "no material," or "breakdown," are also indicated. *Keinath Instrument Co., Columbus, Ohio.*

Lightning Arrester . . .

A new line of distribution valve lightning arresters in 3-, 6-, 9-, 10-, 12-, 15-, and 18-kv ratings features a new type of unitized gap construction in which the functions of both a spark gap and separate coil have been combined in a single, rigid assembly. Rapid magnetic arc movement and power-follow current interruption are accomplished without an auxiliary coil. This method of series gap construction insures precision spacing of gap electrodes and eliminates loose parts, while insuring that the Unigap's original designed and manufactured characteristics will remain unaltered during shipment and after installation. *James R. Kearney Corp., 4236 Clayton Ave., St. Louis 10, Mo.*

Epoxy-Patch Kit . . .

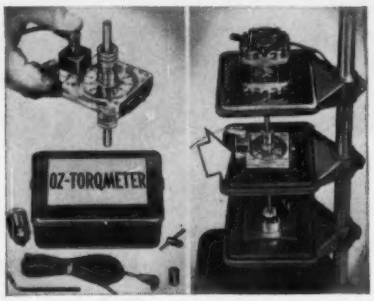
Latest addition to the Epoxy-Patch family is this resilient adhesive for repairing strain gauges or printed circuits, or for glass-to-glass, pyroceram-to-glass, or metal-to-glass bonds. Packaged in flexible tubes for easier handling, the resin and hardener appear cloudy when first mixed, but turn to a clear film in 1 hour. Designated no. *0151*, the epoxy has shear values of 2,400 psi in a thermal range of —50 to 150 F. *Hysol Corp., 322 Houghton Ave., Olean, N.Y.*

Tape Demagnetizer . . .

Serving the dual purpose of degaussing tape on reels without demagnetizing record-playback and erase heads or rewinding, this device will produce complete erasure of recorded signals on all brands of tape, sound film, or metal reels up to 15 inches in diameter. To erase, the demagnetizer is placed on top of the reel and slowly moved about for a few seconds. Application to new tape will help produce recordings with a greater signal-to-noise ratio. *Amplifier Corp. of America, 398 Broadway, New York 13, N.Y.*

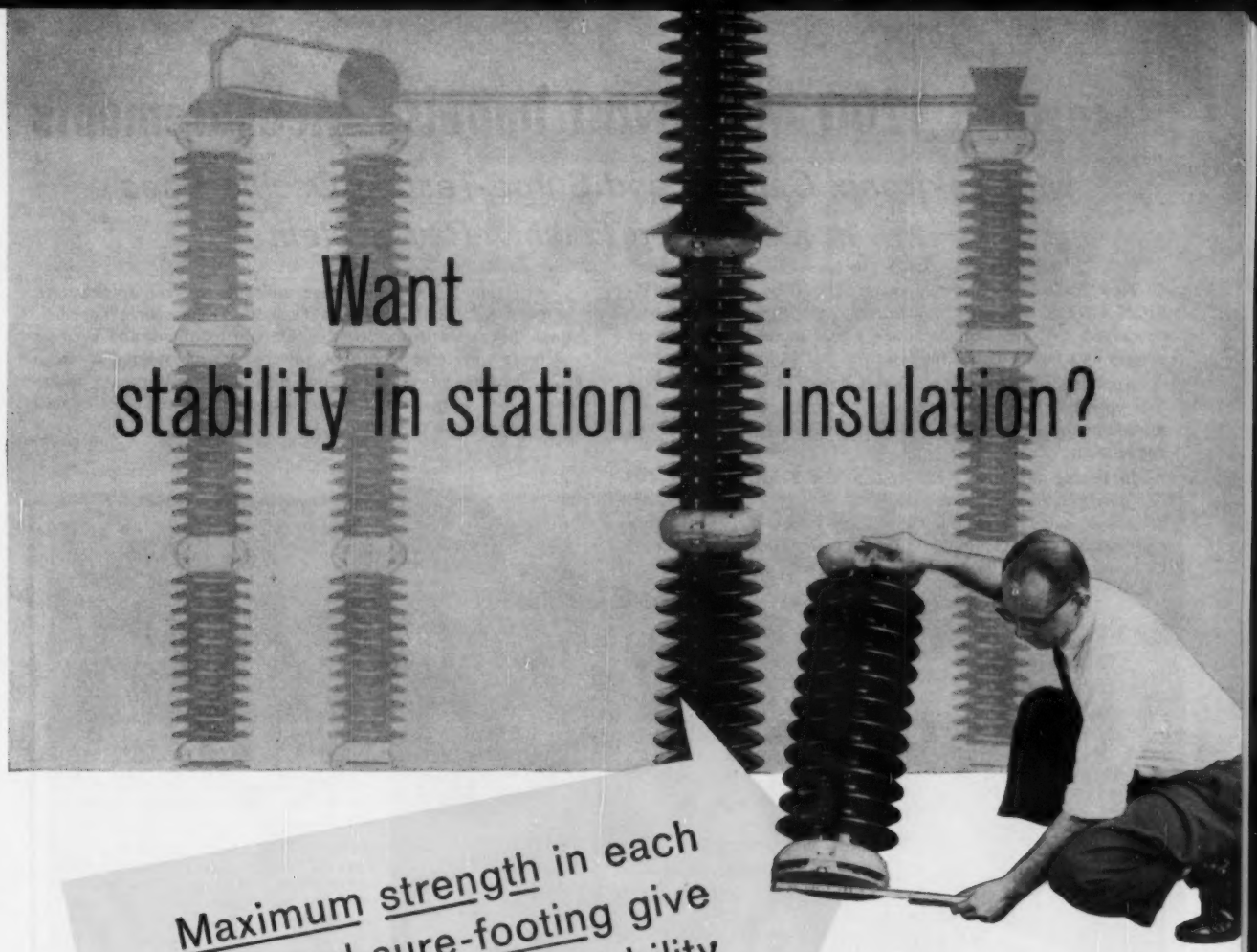
Small Motor Torque Meter . . .

The Oz-Torqmeter, with a range of 0.05 to 25 ounce-inches, was designed for manufacturers of small electric motors to measure the starting, operating, and stall torques, as well as bearing friction. For manufacturers of devices using rotating gears or components, such as electric clocks, remote control positioning devices, gear trains, relays, potentiometers, and small motorized appliances, the instrument will determine the exact torque required,



enabling selection of the right components for most efficient operation. *Power Instruments, Inc., 7325 N. Lawndale Ave., Skokie, Ill.*

(Continued on page 22A)



Want stability in station insulation?

Maximum strength in each joint and sure-footing give O-B Unipost high stability

O-B designed the new Unipost especially for high voltages of our modern stations. Where you need good support, such as for high voltage switchgear, you need all the rigidity, stiffness, and sure-footing you can get. A little excess deflection in an insulator stack may prevent a switch blade from making optimum entry into the clip end of the switch . . . and when switches are seldom operated, you must be doubly sure that your posts are stable. O-B's Unipost will give you that high stability.

The broad base is retained throughout the stack - - between units, at the top and at the bottom. Because of this unique construction, the O-B insulator stack has three times the base area of one using small end caps. Broad base, plus maximum strength in every joint, gives the Unipost stack high stability and rigidity.

To reduce the large bolt circle to the smaller, standard bolt circle found on many switches, simply use the Uniplates that are supplied with each stack. The Uniplate provides universal fit with any existing structure or top attachment, independent of the insulator's own mounting dimensions.

These worthwhile design improvements contribute to good, modern station design. Ask for the interchangeable Uniposts. Your switchgear manufacturer will be glad to supply them on your next switches, or you can specify them on your next stacking post order.

OHIO BRASS COMPANY, MANSFIELD, OHIO
Canadian Ohio Brass Co., Ltd., Niagara Falls, Ont.

Ohio Brass HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

Recording 1200 Megawatt Impulse Measurements

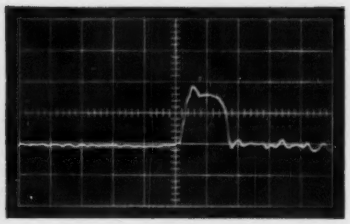
with Tektronix Camera and Surge-Testing Oscilloscope . . . in Monitoring Flash X-Ray System

New Flash X-Ray System manufactured by FIELD EMISSION CORPORATION utilizes an x-ray tube with a newly-developed T-F emission cathode—which increases the current density by a factor of one million over that of a thermal emitter.

Applying square-wave pulse techniques to this high-current T-F emission tube enables the x-ray system to provide stop-motion pictures of high-speed events at velocities up to 30,000 feet per second.

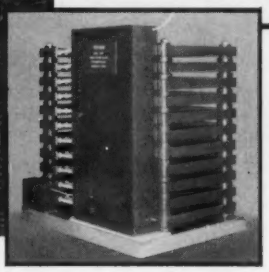
In testing this new x-ray system, the Tektronix Type 507 Oscilloscope monitors the square-wave output from the 1200 Megawatt Pulser to the x-ray tube. The Tektronix C-12 Camera conveniently records critical timing and amplitude measurements of pulses up to 600 kilovolts at 2000 amperes, 0.2 microsecond duration.

For your own high-voltage and high-current applications, consider a C-12 Camera on a Type 507 Oscilloscope. Together, these Tektronix Instruments enable you to obtain and keep an accurate waveform record of power-surge measurements—such as high-voltage breakdown tests of power transformers, insulators, allied components . . . pinch-effect studies . . . other experiments in plasma research.



Adjusting for impedance match of T-F emission tube to square-wave pulse of new x-ray system manufactured by FIELD EMISSION CORPORATION, McMinnville, Oregon.

Using a Tektronix C-12 Camera on a Type 507 Oscilloscope, the Test Engineer conveniently photographs one of many one-shot waveforms taken to record quality-control tests of the x-ray tube.



1200-Megawatt Flash X-Ray Pulser

Type 507 Oscilloscope

Tektronix CRT—new 5-inch CRT at 24-KV accelerating potential provides bright trace on 6-cm by 10-cm viewing area.

Vertical Sensitivity—50 v/cm to 500 v/cm.

Risetime—10 nanoseconds.

Sweep Range—20 nsec/cm to 50 μsec/cm.

Single Sweeps—RESET button arms the sweep circuit for triggering internally, manually, or by an external signal.

Internal Time Markers.

High-Voltage Trip Pulse.

Electronically-Regulated Power Supplies.

Type 507 Oscilloscope **$3000**

Includes Scope-Mobile and separate Power Supply.

(prices f.o.b. factory)

C-12 Camera

- **Undistorted Viewing.**
- **Direct Recording.**
- **One-Hand Portability.**
- **Lift-On Mounting.**
- **Swing-Away Hinging.**
- **Comfortable Viewing**—with or without glasses.

C-12 Camera **$500**

Includes f/1.9 lens with 1:0.9 (object-to-image ratio) complete with cable release, Focusing Back, Polaroid® Back.

**® by Polaroid Corporation.*

For a demonstration of a Tektronix Camera on a Surge-Testing Oscilloscope, please call your Tektronix Field Engineer.

Also, ask him to place your name on the request list for the technical report "Impulse Tests and Measuring Errors"—which will be available soon.

Tektronix, Inc.

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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

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always read between the lines

The *Original*

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Pocket Plate Cells in Steel or Plastic Containers

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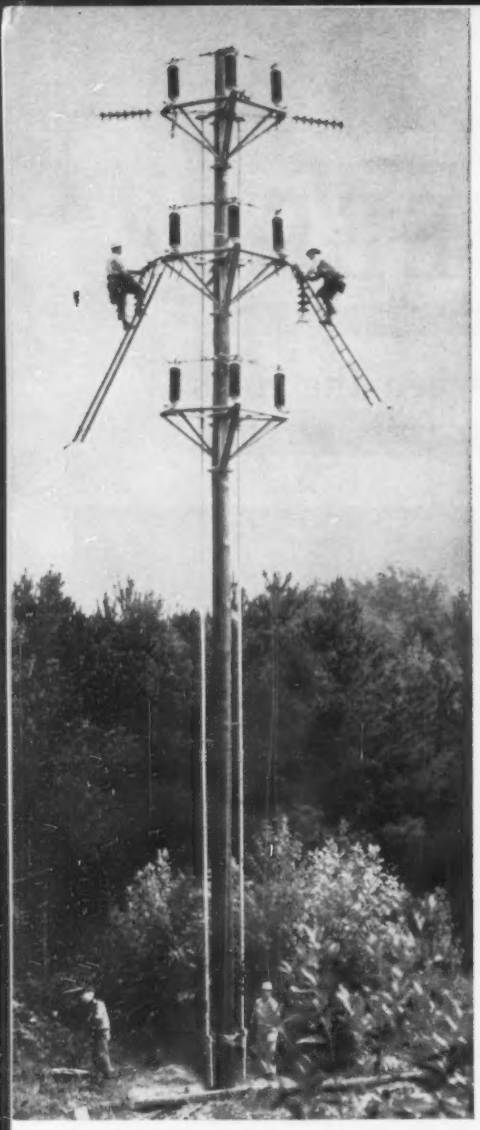
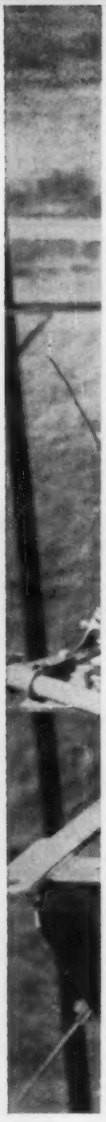


MINIMUM CREW TIME is needed to install Southern States Pole-Pak Air Switches. One pole is all that's needed for three-way switching, compared with conventional arrangements requiring up to six poles. Limited land requirements offer opportunities for installations where other types are not possible. Savings can be substantial.

EXCLUSIVE MOUNTING SYSTEM SPEEDS ERECTION OF SOUTHERN STATES' POLE-PAK



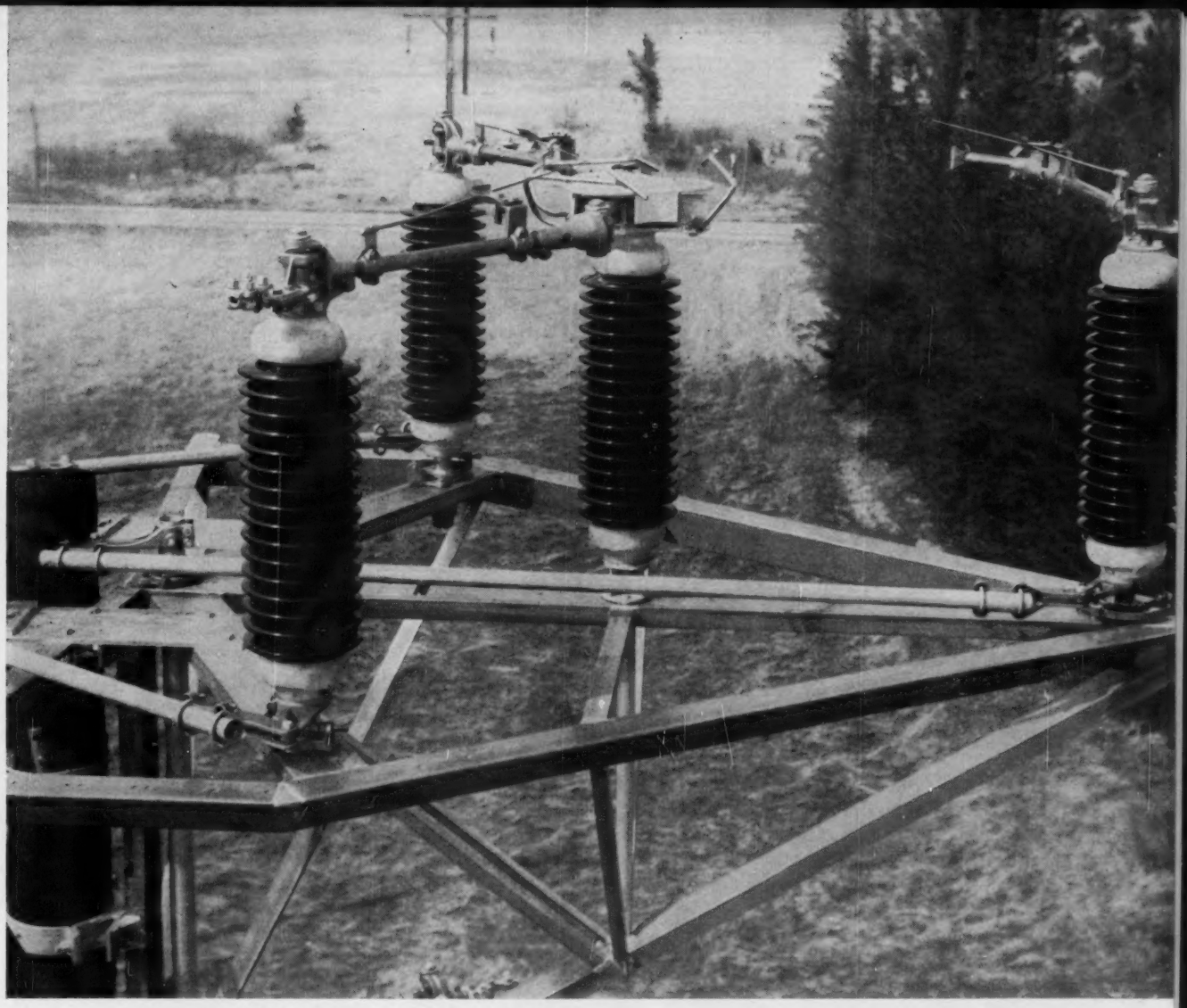
There are many outstanding mechanical and operating features of Southern States Pole-Pak phase-over-phase air switches. But the speed and ease of installation are particularly outstanding advantages.

Southern States employs an exclusive, simplified mounting system. Clamp-type steel bands are fastened to the pole at pre-determined positions. No gaining or drilling is necessary, assuring longer pole life. All switch units are assembled on the ground and hoisted into position. Hooks on the switch frame slip over a mounting plate on the top band, providing temporary suspension and automatically lining up mounting holes for quick and easy permanent bolting. It's that simple!

Other Pole-Pak Features

The Pole-Pak uses Southern States Type 57L braidless air switches. These rugged switches are equipped with Amplitact® contacts, time-proved as the most dependable means devised for handling high short currents.

The Southern States 57L switch is unusually easy to operate. Its blade is designed to toggle into the closed position and has no tendency to open. No force from the operating mechanism is needed to keep the switch closed. The switch is easily oper-



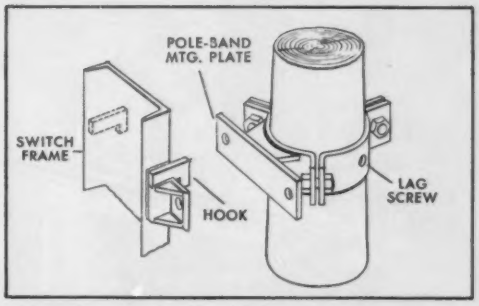
SOUTHERN STATES POLE-PAK is available in voltage ratings from 7.2 kv through 69 kv and continuous current ratings of 600 and 1200 amperes. One- two- or three-way models are available. Southern States Type 57L side-break braidless air switches with Amplitact® contacts are used in the Pole-Pak.

ated by one man, even under icing conditions.

The Pole-Pak frame is constructed of 6061-T6 structural aluminum with adequate bracing for vertical angular pulls in addition to line tensions.

This phase-over-phase method of switching, employing only one pole, with its many time-saving and cost-saving advantages, warrants careful consideration.

Get full information from your Southern States representative, or write for Bulletin 61 PP.



SIMPLIFIED MOUNTING results from exclusive system. Steel band is clamped to pole. Two lag screws prevent slipping. Hooks on switch frame slip over pole-band mounting plate. No drilling or gaining of pole is necessary.

SOUTHERN STATES
HAMPTON, GEORGIA

IN CANADA: DOMINION CUTOUT CO., LTD., TORONTO

Owner: **Western Hotels, Inc.**
Electrical Engineer: **Mr. Fritz Klawa,** Portland, Ore.
Electrical Contractor: **Pitman Electric Co.,** Portland, Ore.

Electrical Protection is MODERNIZED with BUSS Fuses in the Multnomah Hotel, Portland, Ore.

In this well-known hotel of the Northwest, it became necessary to modernize the electrical system to take full advantage of the many uses for electricity today.

BUSS Hi-Cap and FUSETRON dual-element fuses were installed to assure safe, dependable and lasting protection.

This installation is another example of the modern trend in electrical protection. Architects, engineers and plant operating men are finding no other type of protective device can equal fuses for high-interrupting capacity and lifetime, maintenance-free dependability.

FUSES PROVIDE HIGH INTERRUPTING CAPACITY

at a very low cost

FUSETRON dual-element fuses have an interrupting rating of 100,000 ampere rms symmetrical—and for the protection of mains or circuits above 600 amperes, BUSS Hi-Cap fuses are designed to safely interrupt 200,000 ampere rms symmetrical.

Thus, they can safely interrupt fault currents now available,—and are adequately safe to allow for future system growth.

Mr. J. Wesley Birch, Manager of Pitman Electric Co. at main switch board which is equipped with BUSS Hi-Cap and FUSETRON dual-element fuses.

If you need fuses with long time-lag to prevent needless blows, plus 200,000 amp interrupting capacity, plus extreme current-limitation—use **BUSS LOW-PEAK** fuses.

Ask for BUSS bulletin LPCS.

WITH FUSES, SAFE PROTECTION REMAINS SAFE WITHOUT MAINTENANCE OR RECALIBRATION COSTS

After years of inactivity, fuses will provide the same safe, accurate protection if called upon to open as they would on the day installed.

Fuses have no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase the capacity of fuses or lengthen their blowing time.

For more information:

Fusetron dual-element fuses.....write for bulletin FIS
BUSS Hi-Cap fuses.....write for bulletin HCS

BUSSMANN MFG. DIVISION, McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

561

Maintain a low power factor by keeping the insulating oil clean, stable, and efficient. Because copper, oxygen and heat are present, the insulating oil in any paper insulated cable is subject to oxidation and gives off products that increase power factor. Anaconda greatly reduces this power factor increase by wrapping each conductor and the insulation in highly adsorbent carbon-black tapes. These patented tapes adsorb the oxidation products that the oil develops, keeps them outside the dielectric field. Result—the oil remains clean, pure and dielectrically stable far longer.

These remarkable tapes provide other advantages too. They reduce strand discharges. They also diminish surge currents, and provide remarkable cable stability even when subjected to severe loading cycles.

Because Anaconda supplies all the accessories you need, you also get the advantages of completely compatible components and the reassurance of unit responsibility by the manufacturer.

For more information about Anaconda CB* cable, contact the Man from Anaconda or Dept. EFL-1-EE, Anaconda Wire and Cable Company, 25 Broadway, N. Y. 4, N. Y.

CALL THE MAN FROM

ANACONDA®

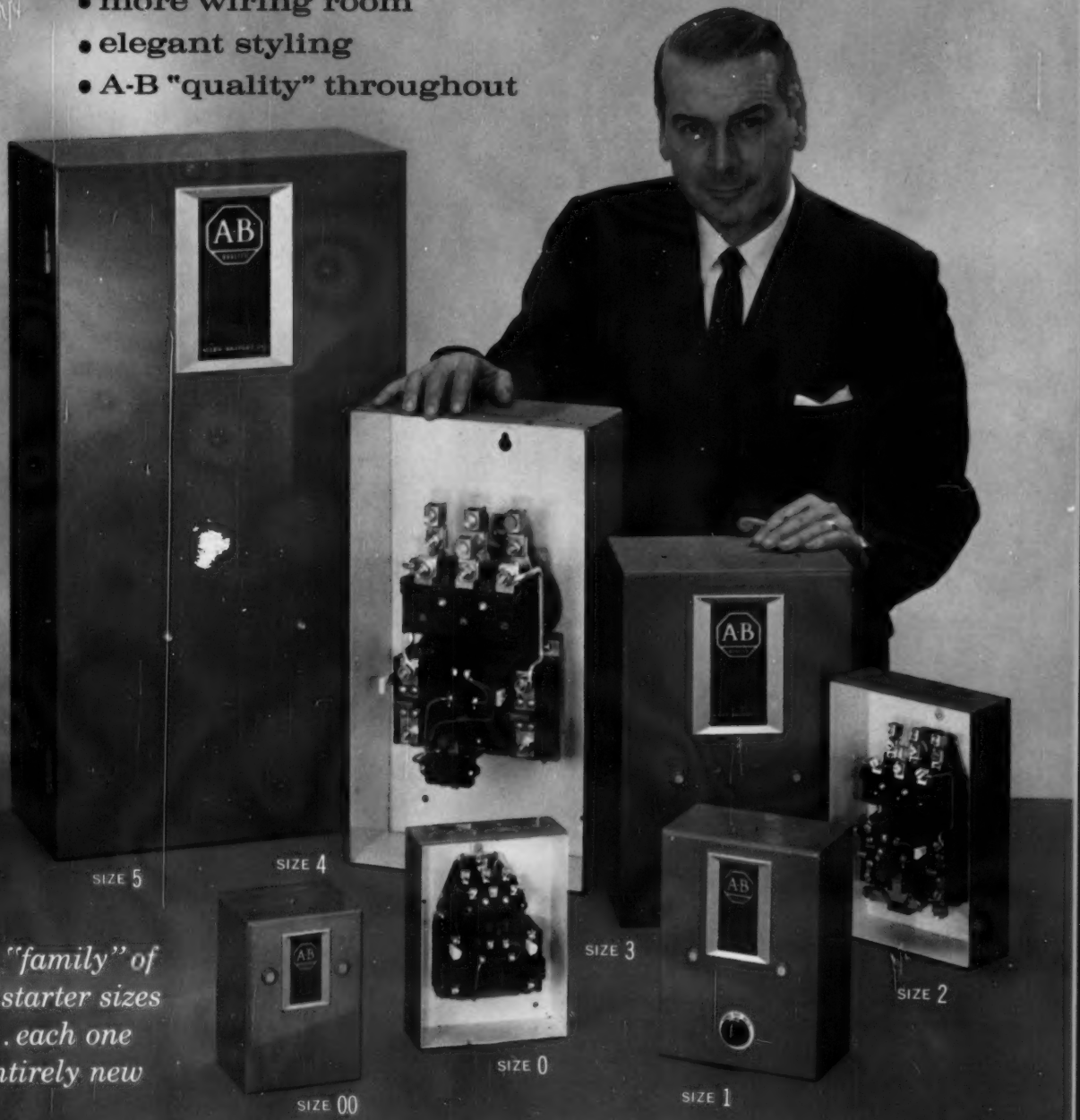
CB* POWER CABLE

61245

*Reg. U. S. Pat. Off.

a new line of Bulletin 709 motor starters by ALLEN-BRADLEY

- smaller size
- greater interrupting capacity
- even more millions of trouble free operations
- more wiring room
- elegant styling
- A-B "quality" throughout



A "family" of 7 starter sizes ... each one entirely new

greatest advance in motor control in 30 years

In appearance . . . in performance . . . in physical size and weight . . . these Allen-Bradley Bulletin 709 solenoid starters are *completely new in every way!*

NEW COMPACTNESS. Size reductions are so drastic you'll hardly believe your eyes. The tables below will give you some idea of how the new line of Bulletin 709 starters compares with the old.

A TREMENDOUS INCREASE IN LIFE—both mechanical and electrical. All of these new starters are good for many more millions of trouble free operations.

NEW PATENTED MAGNET. For its weight and size, the most powerful magnet used on motor control. Its short, cushioned stroke assures long contact life. A new, permanent air gap prevents any possibility of magnetic sticking. "Snap action" guarantees positive contact opening and closing.

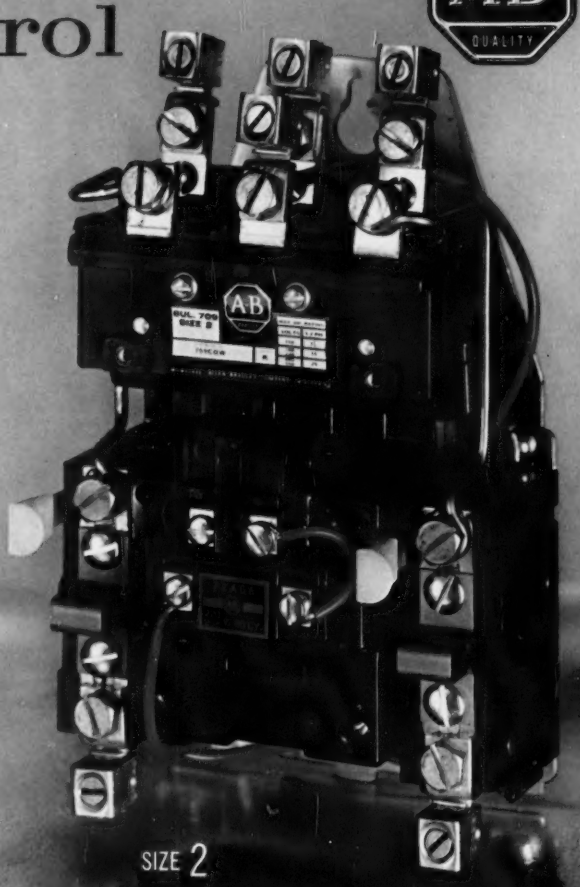
NEW MOLDED COIL. Impervious to atmospheres that could cause trouble, and also protected against mechanical damage. All coils are easily removed—from the front of the starter.

NEW CONTACTS. New double break contacts of cadmium oxide silver resist welding . . . close and seat firmly without sliding or wear-causing motion.

NEW OVERLOAD RELAYS. Not only "trip-free" but also "tamperproof," to reliably protect motor and machines. Of course the new relays were designed to use the old Bulletin 709 heating elements which you have in stock.

NEW ENCLOSURES. Completely restyled by Brooks Stevens—and so modern. They are a sales asset on any type of modern machine or industrial installation.

BETTER WRITE FOR MORE INFORMATION ON THIS REVOLUTIONARY NEW BULLETIN 709 STARTER!



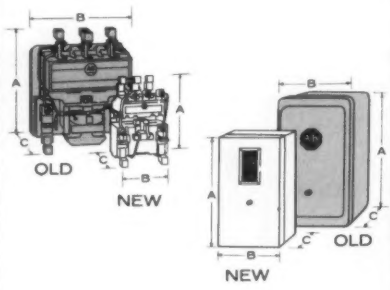
SIZE 2

New Bulletin 709 Solenoid Motor Starter

CHECK THE "NEW" WITH THE "OLD" BULLETIN 709 DIMENSIONS

The wiring room in the new enclosures will delight the electrician.

Starter Size	OPEN TYPE STARTERS					
	NEW			OLD		
	Height A	Width B	Depth C	Height A	Width B	Depth C
00	3⅝	3⅞	3⅜	—	—	—
0	5⅞	4 1/16	3 11/16	5⅝	4¾	3¼
1	6⅝	4½	3 11/16	5⅞	5	3¼
2	7¾	4⅝	3 11/16	10 1/16	5¾	4 7/32
3	10¼	6¼	5 7/16	12⅝	7¼	5 7/16
4	11 7/16	7 3/16	6¼	16¼	12¾	6 13/16
5	14 13/16	9	6½	20	16⅛	8¾



Starter Size	NEMA 1 ENCLOSURES					
	NEW			OLD		
	Height A	Width B	Depth C	Height A	Width B	Depth C
00	7⅝	4⅞	4¼	—	—	—
0	9⅛	6 5/16	4⅜	7⅞	5⅝	4¼
1	10	6 13/16	4⅜	8 13/16	6⅜	4¼
2	12	7⅝	4⅜	14½	9	5 7/16
3	16⅝	10⅜	7	19½	11⅜	6 11/16
4	22	11⅝	8	26 9/16	14 1/16	7 11/16
5	32 1/16	17 1/16	9⅞	41½	19 9/16	13 9/16

8-61-RM

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Member of NEMA

Quality Motor Control

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wisconsin

Only from OHMITE

MIL-R-19365C Across the Board!

OHMITE "Dividohm®" Adjustable Resistors

HIGHLIGHTS OF MIL-R-19365C—This revised specification covers power-type, wire-wound, adjustable resistors from 1 to 15,000 ohms inclusive. Resistance tolerance is specified as ± 5% for all eight power ratings which are listed at right. The maximum continuous operating temperature is 350°C (Char. V).

MIL-R-19365C resistors are the tubular type with single-layer windings and lug-type terminals—two fixed and one adjustable.

Ohmite can supply all eight adjustable resistors to meet *every* requirement of MIL-R-19365C. Higher resistances using smaller wire sizes are available, also, to meet the performance requirements of this new MIL specification.

Write for Military Catalog 50B—the "Easy Way" to Order MIL Resistors.

STANDARD MIL-R-19365C ADJUSTABLE RESISTORS

		DIMENSIONS		OHMS	
STYLE	WATTS	LENGTH	DIA.	MIN.	MAX.*
RX29	11	1¾"	7/16"	1	470
RX32	17	2"	9/16"	1	910
RX33	26	3"	9/16"	1	1,500
RX35	55	4"	29/32"	1	3,600
RX36	78	4"	1 5/16"	1	5,100
RX37	113	6"	1 5/16"	1	8,200
RX38	159	8"	1 5/16"	1	11,000
RX47	210	10½"	1 5/16"	1	15,000

*0.004" Diameter wire.

OHMITE MANUFACTURING COMPANY

3614 Howard Street, Skokie, Illinois

Rheostats Power Resistors Precision Resistors
Variable Transformers Tantalum Capacitors
Tap Switches Relays R.F. Chokes
Germanium Diodes Micromodules

OHMITE

Offering you complete availability of these MIL resistors so quickly is another indication of Ohmite's ability and desire to give industry the finest, most advanced resistance products with the best of service.

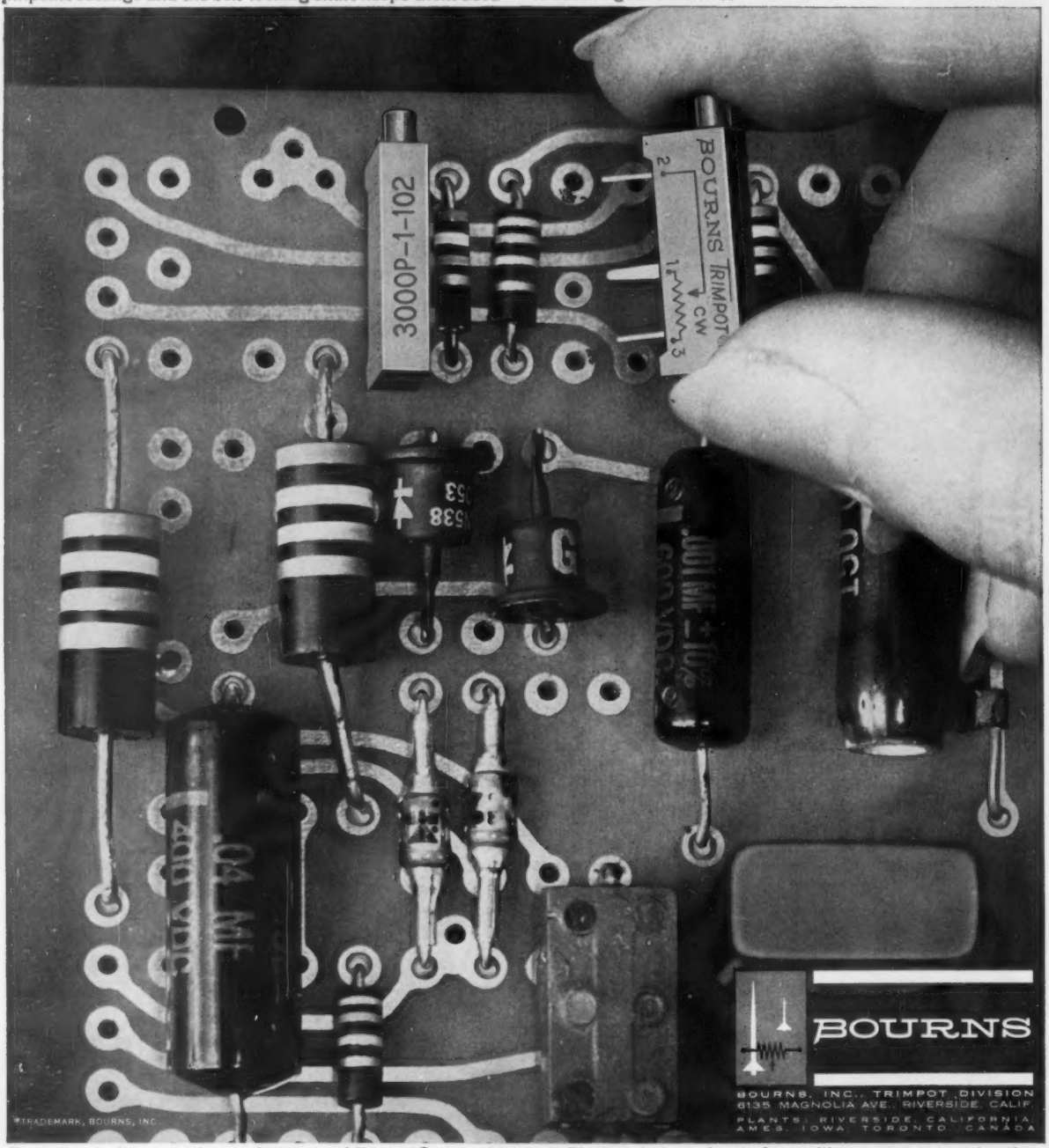
Now—an Even Smaller
High-Temperature Trimpot® Potentiometer

NUMBER 13—NEW PRODUCT SERIES

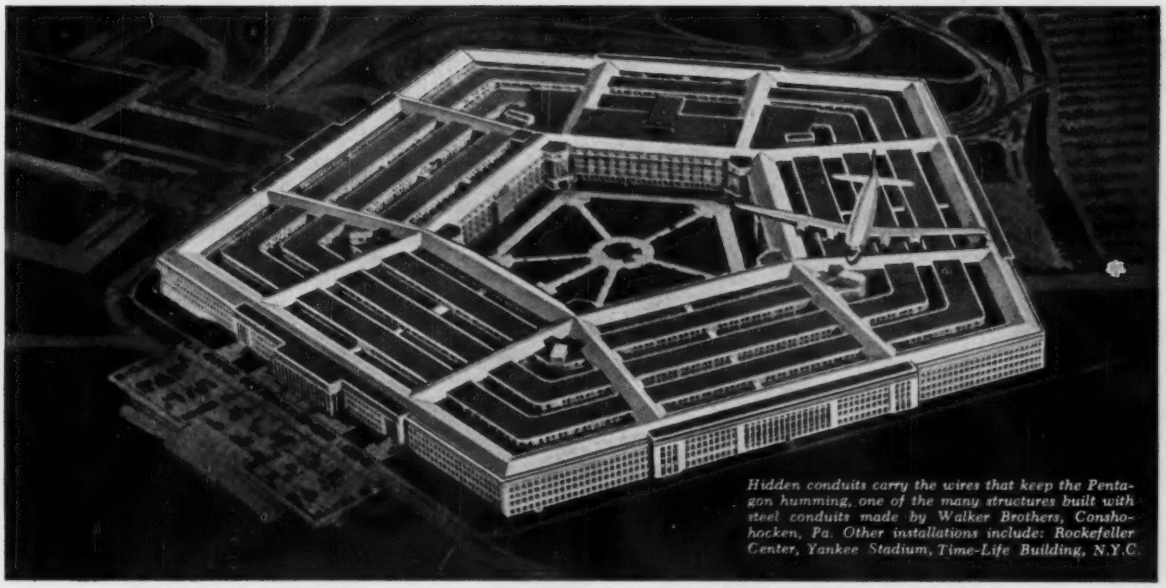
Here, just ¾" in length, is a wirewound potentiometer that is completely humidity-proof and operates at 175°C! Ideal for your printed circuit applications, it withstands 30G vibration and 100G shock, dissipates 0.5 watt at 70°C (0.2 watt at 125°C), and has tapered pins for quick, easy mounting.

Sealed against humidity in a high-temperature plastic case, the Model 3000 exceeds the requirements of MIL-STD-202A, Method 106. The 15-turn screwdriver adjustment permits pinpoint settings and the self-locking shaft keeps them accurate. For maximum stability, the unit incorporates a ceramic mandrel. Reliability is outstanding. The exclusive Silverweld® bond between terminal and resistance wire is virtually indestructible under thermal or mechanical stress.

Available within 24 hours from factory and distributor stocks, the Model 3000 is stocked in resistances of 50 ohms to 20K. A Resiston* carbon version, Model 3001, is available with resistances of 20K to 1 Meg. Write for complete data and list of stocking distributors.



Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure, acceleration.



Hidden conduits carry the wires that keep the Pentagon humming, one of the many structures built with steel conduits made by Walker Brothers, Conshohocken, Pa. Other installations include: Rockefeller Center, Yankee Stadium, Time-Life Building, N.Y.C.

Sel-Rex Rectifier Helps Walker Brothers Meet Up-To-The Minute Delivery Schedules!!

The Pentagon, as with many modern structures, is honeycombed by thousands of Walker Brothers conduits and ducts that carry miles of telephone, dictaphone and low voltage electrical wiring.

Getting these tons of rigid steel conduit to the initial construction site calls for adherence to precise building schedules—timing deliveries to meet contractors' hoist schedules. Otherwise costly delays result; deadlines are disrupted.

Walker Brothers Conduit Division, Conshohocken, Pa., assures on-time deliveries with the help of a Sel-Rex Silicon Rectifier. It powers the plant's giant overhead cranes that lift, haul and load tons of steel every day.

The rectifier was chosen for a special reason: when the company's motor generator suffered a breakdown, a virtually complete production shutdown resulted. To prevent a recurrence, Walker selected a Sel-Rex Rectifier to supply its D.C. requirements . . . chosen because "it has no rotary parts to wear out, has low installation cost, negligible maintenance and low operating cost."

These statements from a Walker Brothers official make good sense. They are the same sound reasons why thousands of firms have chosen Sel-Rex Rectifiers as their modern, trouble-free source of dependable D.C. power.

Tons of steel conduit made at the Conshohocken, Pa. plant of Walker Brothers are carried by overhead cranes powered by a Sel-Rex Silicon Rectifier.

Send for Free "GUIDE" to Industrial Rectifier Equipment

THE MEAKER COMPANY

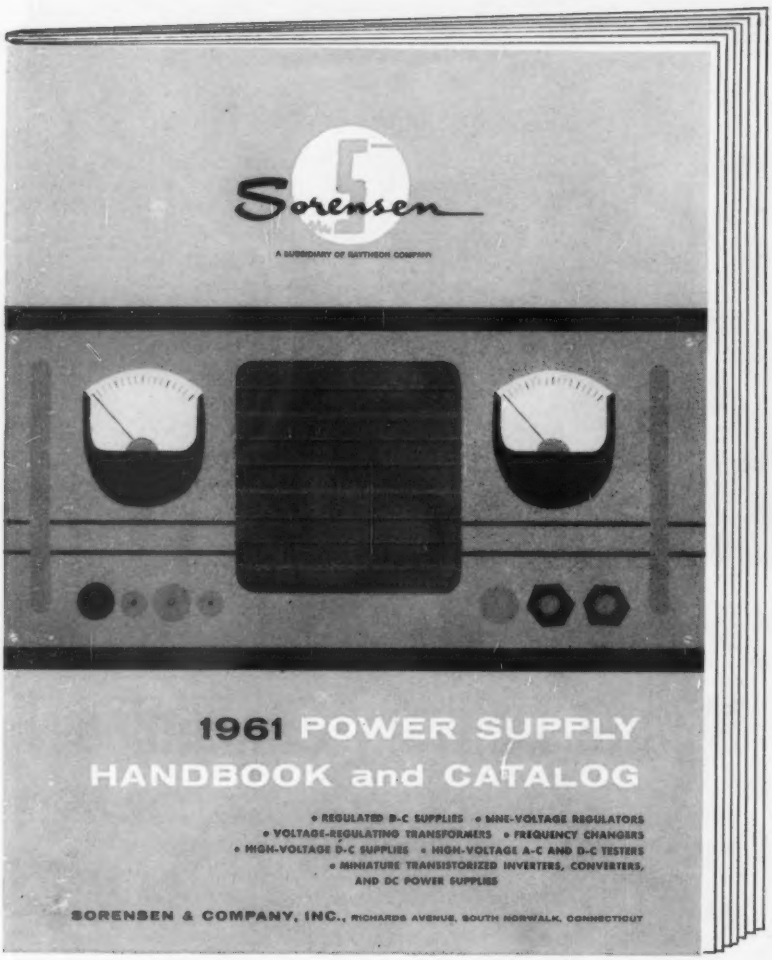
SUBSIDIARY OF SEL-REX CORPORATION

Nutley 10, New Jersey

Factories and Offices Chicago 50, Ill., Los Angeles, Cal. and Nutley 10, N. J.

Representatives in principal cities.

Complete Semi-Conductor Power Conversion Equipment and Systems for any AC to DC Application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HANDBOOK and CATALOG
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● Regulated d-c power supplies ● Line-voltage regulators ● Voltage-regulating transformers ● Frequency changers (variable-frequency power sources) ● High-voltage d-c supplies ● High-voltage a-c and d-c testers (to 300,000 volts) ● Miniature transistorized inverters, and converters.

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The widest line—your wisest choice

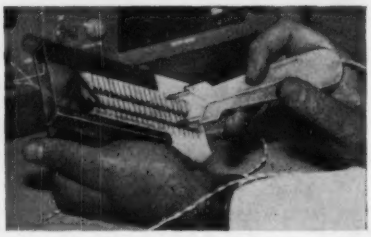
A SUBSIDIARY OF RAYTHEON COMPANY

New Products

(Continued from page 8A)

Novel Diode Packaging . . .

This new diode shipping container allows the purchaser to test incoming diodes without removing them from the package. Called Test-Pak, the container consists of a styro-foam block which encases the diodes and holds the leads of each diode in a rigid position. A channel cut in the styro-foam on both sides of the diodes exposes a portion of each diode lead. A special test



jig furnished with each shipment plugs into the diode tester. The operator runs the prongs of the test jig down the channel to make contact with both leads of each diode. *Delta Semiconductors, Inc., 835 Production Place, Newport Beach, Calif.*

Optical Heat Sensor . . .

This infrared control unit senses surface temperatures optically and may be used wherever material is in motion or would be damaged by direct contact. Capable of reading surface temperatures from 120 to 1,200 F, the sensing head can be connected to a reading unit or a modified recorder for experimental work, or to a control unit for automatic processing. The field of view is 1/30 of working distance approximating 30 inches. Stability is ±2 degrees. *Williamson Development Co., Inc., 317 Main St., W. Concord, Mass.*

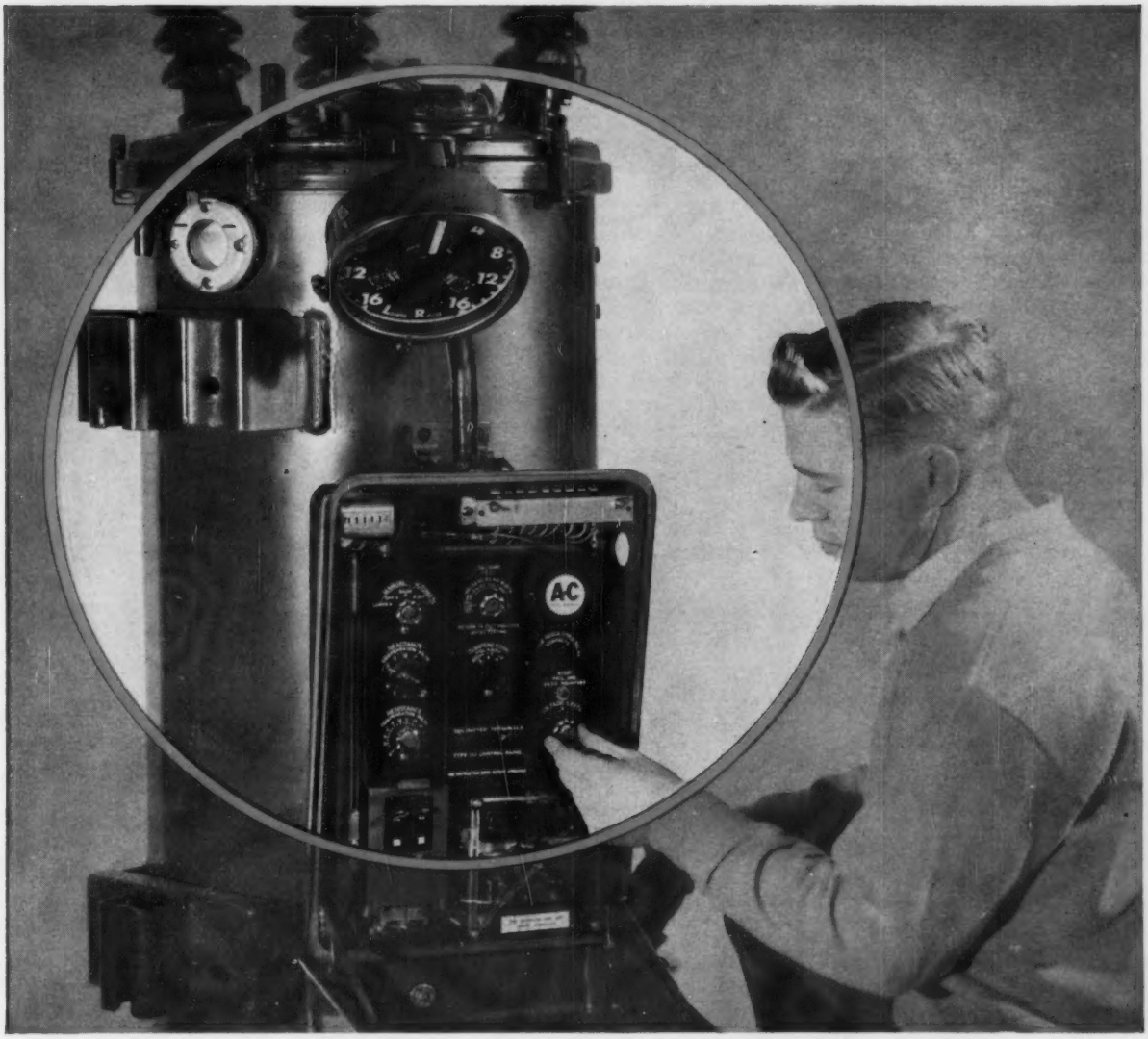
Component Marker . . .

These self-adhering serialized markers were designed to identify each miniature and subminiature component on matrix boards and circuit cards. By assigning each component a number and subsequently identifying it with a data-processing card, one can quickly trace any malfunctioning of that part through its corresponding data card. Markers are 1/16 by 3/16 inches and are printed on material resistant to most solvents and chemicals. *Westline Products, 500 E. 2nd St., Los Angeles, Calif.*

(Continued on page 28A)

ALLIS-CHALMERS

Originators of 5/8% Step Regulators



"Magic Circle" control center

Puts all JFR regulator indicators, controls at operator's fingertips!

Completely electrical adjustment with famous *Feather-Touch* control accurately sets narrow band widths and voltage levels.

Fingertip-adjustable *Caliband* control cuts setting time without changing customer voltage or compensator settings.

Electrically resettable position indicator drag hands eliminate pole climbing or "climber" damage!

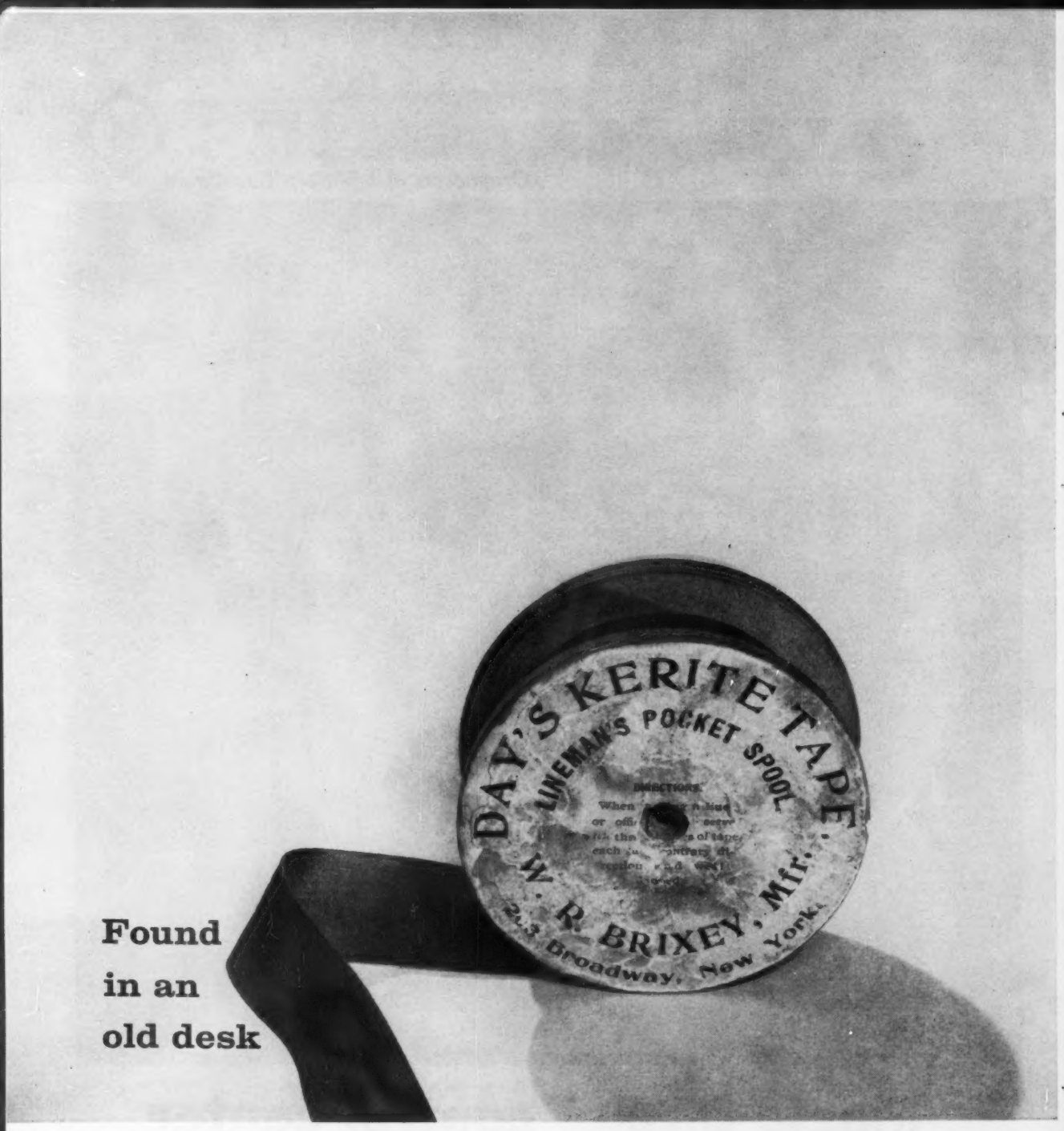
Conveniently located oil sight gauge permits checking oil level at a glance.

Six-digit counter records up to one million operations, simplifies record keeping and detects excessive operations.

Snap-action *Vari-Amp* control for positive settings.

Specify **Allis-Chalmers** *Regulators . . . call, wire or write your nearby A-C office.* A-1444

Feather-Touch, Vari-Amp and Caliband are Allis-Chalmers trademarks.



Found in an old desk

When this spool of tape was new, the twentieth century had not yet been born. Salty old Captain Brixey owned the Kerite business and was making cable history.

His Kerite wire had been used for a 300-mile railway block-signal system . . . the longest aerial cable of its time. A Kerite 1,000,000 circular mil power cable laid in the Gowanus canal was already ten years old in 1908 and "just as good today as it ever was and giving the best possible service."

One of the Captain's most colorful projects was the Kerite cable laid along the Panama Canal, the first telegraph connection between North and South America. The joints were made with Kerite splicing compound (Kerite insulation in tape form). These joints were not only dielectrically sound but had to match the cable insulation in terms of insulation resistance and capacity in every way. Thirty miles of this cable were submerged, but in jungle and water, cable and tape stayed in service for over forty years.

A lot of time has gone by since this spool was young.

Yet this old tape is apparently as flexible and strong as on the day it was made.

The Kerite Co., 30 Church St., New York 7, N. Y. Agents in all principal cities. A member of the Railway Progress Institute.

KERITE

Premium grade insulated wire and cable . . . friction tape, splicing compound tape, rubber cement.

ON THE SHELF— ARNOLD CORES IN WAREHOUSE STOCK FOR IMMEDIATE DELIVERY

Let us handle your inventory problems and save you time and money on your magnetic core requirements.

Extensive stocks of four types of Arnold cores in the most popular sizes have been set up in our Marengo, Illinois and Fullerton, Calif. plants. Subject of course to temporary exhaustion of stock by prior sales, these cores will be shipped *the same day* on orders received at the warehouse by 12:00 noon. When cores are out of stock at the nearest plant, we may be able to ship within 24 hours from the other.

Arnold core products covered by this warehouse stock program include: 1) Silectron C, E and O cores in 2, 4 and 12-mil tape. 2) Type 6T aluminum-cased cores of Deltamax, Square Permalloy and Supermalloy, in 1, 2 and 4-mil tape. 3) Mo-Permalloy powder cores, both temperature-stabilized and unstabilized types, ranging down to "cheerio" sizes. 4) Iron powder toroids, threaded cores and insert cores.

All four products are available in a wide range of selection, for your convenience and economy in ordering either prototype design lots or regular production quantities. • Stock lists, bulletins, etc. are available—write for information. *The Arnold Engineering Company, Marengo, Ill.*

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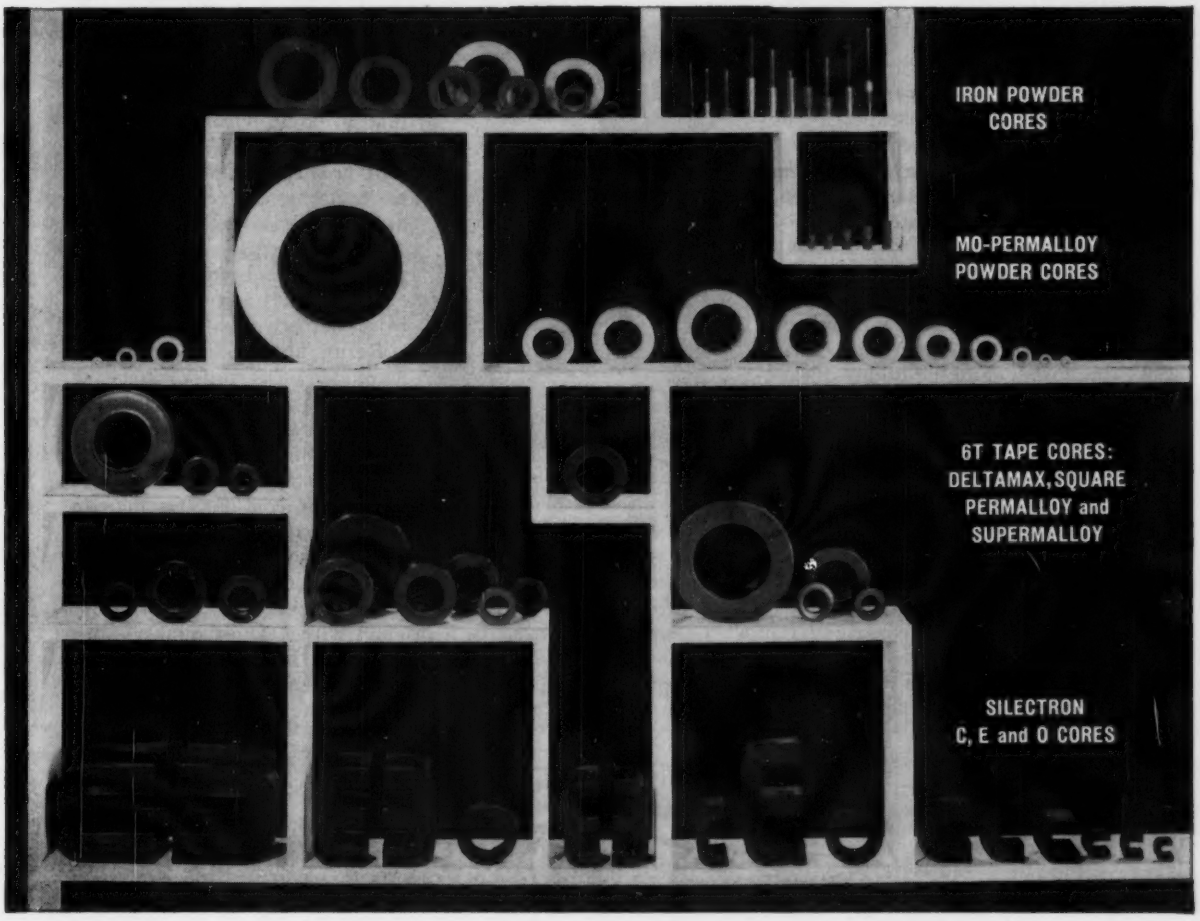
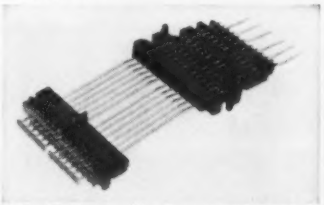

IRON POWDER CORES
MO-PERMALLOY POWDER CORES
6T TAPE CORES: DELTAMAX, SQUARE PERMALLOY and SUPERMALLOY
SILECTRON C, E and O CORES

Hardly larger than cigarette packages, wire spring relays form the heart of switching apparatus for more than 200-million telephone calls a day. The pencil indicates the top row of tiny palladium-capped contacts which are vital to the relay's switching functions.

Probing for palladium via thermoelectricity

Wire spring relays are vital to the Bell Telephone System's reliable, high-speed switching equipment. Western Electric will manufacture more than 13 million relays in 1961. Palladium-capped contacts on these relays are necessary for their optimum performance—therefore, positive verification of the palladium is essential.

Verification by existing means has proved to be extremely difficult, however, because of the caps' size (only 1.01 x 0.73 x 0.042 inches) and the fact that the palladium and the cupro-nickel base blocks to which the caps are welded are similar in color, making visual checking highly unsatisfactory. Also, the characteristics of the metals involved make ordinary electrical and magnetic methods impractical.



The single wire block – a component of the wire spring relay – showing the cupro-nickel contact points, some of which must be capped with palladium.

Contact verification machine, developed and built by Western Electric, being programmed to check wire blocks for dielectric breakdown, physical configuration, and palladium contacts.

To overcome this problem, Western Electric engineers have developed and built an ingenious machine which utilizes the Seebeck thermoelectric effect, by which an electrical circuit made up of two different metals generates an electric current when the junction between the two metals is heated. In this case, nickel and palladium were the metals involved, but another feature of the Seebeck effect is that a circuit composed of nickel and cupro-nickel generates a current *which flows in the opposite direction.*

The engineers made use of this feature by using nickel probes — preheated to 300 degrees Fahrenheit — in the new machine. The probes touch all contacts on the relay's single wire block assembly, and the *direction* of the current produced indicates whether the probe has contacted palladium or the cupro-nickel base metal. Amplifier circuits enable the "indicator" currents to operate automatic controls and automatically reject defective assemblies.

Being able to intentionally leave caps off certain pre-selected contacts is also a prime advantage of this new verification process, since hundreds of thousands of relays use less than the maximum number of contacts. Savings in material costs, which are made possible by omitting precious palladium from unused contacts, are significant. But the most important advantage of the process is the proven ability to produce a product with verified quality – the kind of quality required by the Bell System's twenty-three local telephone companies to give highly dependable telephone service.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

OERSTED
and the
Discovery of Electromagnetism

BERN DIBNER
FELLOW AIEE

. . . Call Pythagoras and bid
The sage to mark the laws divine which rule
Each planet's course; and when he reads and sees
Such harmony amidst the countless worlds,
Trembling with joy his heart will overflow
Before the sacred concert of high reason.
—Oersted, *The Soul in Nature*

A NEW epoch commenced in 1800 when Alessandro Volta announced his discovery of a way of producing continuous-current electricity. On March 20 of that year a letter was dispatched by Volta from his home in Como, Italy, to Sir Joseph Banks, president of the Royal Society in London. Because of a state of war between England and France, the letter arrived in two sections and was finally read before the Royal Society on June 26, 1800. It was subsequently published in the *Transactions of the Royal Society* that year. No other event was more influential in shaping modern history.

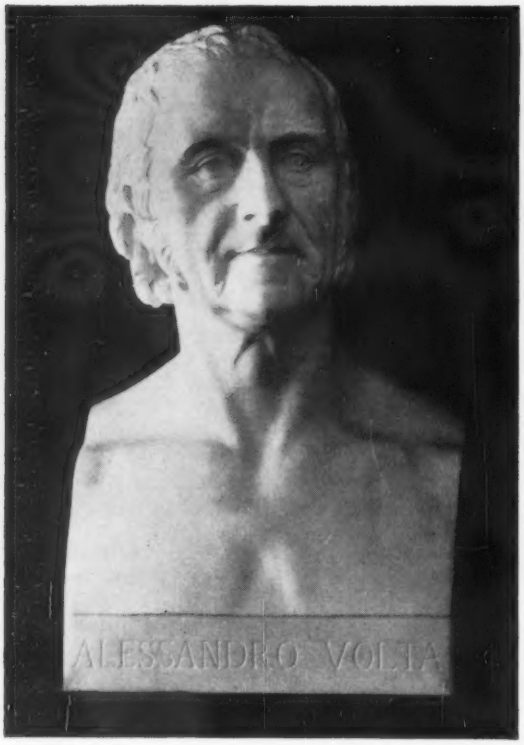
It must be realized that the air in the nations on both sides of the Atlantic was at that time charged with revolutionary zeal and promise. The young United States had not yet attained its majority as a nation, indeed its first president had died but a few months before. France was gripped by revolutionary excitement in which reason had replaced faith, new ideas in society were being instituted and science was given a new and prominent place in the revolutionary program. Luigi Galvani's announcement in 1791 of his discovery and demonstration of "animal electricity" had revealed the presence of forces in nature that had previously been unknown. The growth in number and influence of experimental societies and the correspondence between amateurs of experiment had stimulated the search for more of the unknown forces and newly disclosed relationships in the physical and biological world. Galvani had influenced Volta into repeating experiments to demonstrate the presence of animal electricity. Although first in agreement with Galvani's interpretation, Volta, a keen and exhaustive experimenter, reached a different conclusion as to the causes of the muscular action wherein excised animal tissue, such as dissected frogs' legs, would go into convulsive motion when touched by joined prods of dissimilar metals.

Thus, events in the laboratories led to the development of the Voltaic pile, and an entirely new form of electrical excitation was made possible. An electric current flowed in a circuit formed by a wire connecting pairs of discs or strips of dissimilar metals immersed in brine or a weak acid electrolyte. The first of two forms of an electrical device featured in Volta's communication to the Royal Society consisted of a pile of silver and zinc discs, each pair of which was separated from the adjoining pairs by paper or cloth separators soaked in brine. The second form that Volta developed to illustrate a variant source of constant-flow electricity was his "crown of cups." This consisted of a ring of cups filled with brine and connected by alternate strips of zinc and silver joined by metallic jumpers. This was an improvement over the pile because it avoided the weakening of the current flow as the brine in the separators dried out. Further improvements occurred when copper replaced silver and when dilute sulphuric acid was substituted for brine in the cups. With these piles, wires connecting the two outer elements were shown to be capable of decomposing water, melting fine filaments of metal, stimulating muscular contraction in animals, and creating a sour taste upon the tongue.

So startling was the announcement of Volta's discovery that scientists on both sides of the Atlantic repeated and expanded Volta's experiments. In November 1801 Volta demonstrated the action of the new electrical source in Paris before an assembly of scientists attended also by the First Consul, Napoleon Bonaparte, in a session that brought the two men into conversation for several hours. Napoleon proposed to his minister, Chaptal, that prizes be established to encourage new research into galvanism, adding "Galvanism, in my opinion, will lead to great discoveries." One prize was to be awarded

This article is a serialization in four parts of the book of the same name published by the Burndy Library, Norwalk, Conn.

Bern Dibner is chairman of the board, Burndy Corporation, Norwalk, Conn.



Stimulated by the work of Galvani in "animal electricity," Alessandro Volta, professor of physics at Pavia, discovered a chemical source of constant-current electricity with the invention of the voltaic pile. This opened a new era in science.

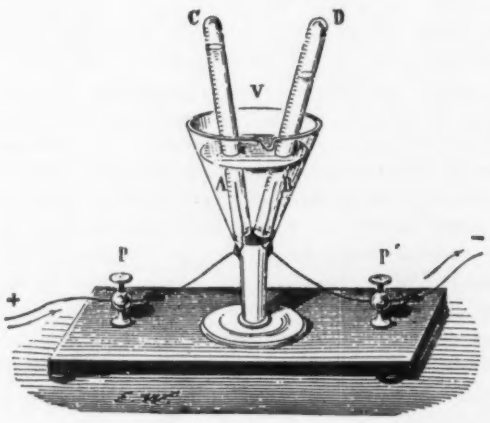
to the one who contributed experiments or discoveries in electricity or magnetism comparable to those given to these sciences by Franklin and Volta.

Thus, the stage was set for yet another step in scientific evolution. On a cosmic scale we have, in the history of science, examples of the development of theories that depended on the slow accumulation of data from which, by analysis and induction, a Copernicus proposed the heliocentric system or a Darwin the doctrine of evolution. In the case history we are now examining, the discovery of electromagnetism is an instance of a simple but prime relationship between basic physical forces that eluded recognition and formulation for two active decades in spite of the many minds that were concerned with related phenomena.

THE ELECTROCHEMISTS

EVEN BEFORE the delayed second part of Volta's letter had reached the Royal Society, the chemist William Nicholson, aided by the English surgeon Anthony Carlisle, constructed a voltaic pile and proceeded with chemical experiments. Water was decomposed by the pile, which consisted of 17 large silver coins separated by an equal number of copper discs. Each such pair was separated from the adjoining pairs by bits of cloth soaked in a weak brine solution. Gas was observed to bubble at the juncture of the conducting wire to the pile where a drop of water had been added to improve the conductivity of the juncture. This crude assembly was replaced on May 2, 1800 by a glass tube filled with water and having brass wires connected to the pile terminals entering each end of the tube through a cork stopper. Hydrogen formed at the negative terminal and oxygen at the positive one. William Cruickshank repeated and confirmed the experiments of Nicholson and Carlisle showing that hydrogen evolved from the silver or copper section of the pile and oxygen from the zinc. By adding litmus coloring to the water, the zinc end showed a red tinge in the fluid near the terminal. This phenomenon was seized upon by several inventors as a means for distant electric telegraphy. Cruickshank also improved the voltaic pile by arranging rectangular zinc and copper plates in a resin-insulated wooden trough and with this decomposed several compounds, and electroplated metals. A new research tool came into the hands of the experimenter. The spectacular experiments performed in the late 1700's with the use of electrostatic generators gave way to the more prosaic and corrosive electric battery. Sparks, halos, and pinwheels were replaced by the deeper and more challenging phenomena that issued from the ends of an electric battery assembly.

In England the most ambitious experimenter with the new source of electricity was Humphry Davy, professor of chemistry at the Royal Institution in London. With the help of William H. Pepys, an instrument maker and a Fellow of the Royal Society (FRS), the strongest voltaic pile of its time was constructed in February 1802 for Davy. It consisted of 60 pairs of zinc and copper plates, each 6 inches square. With this, Davy melted iron wires up to 1/10 inch in diameter and platinum wires 1/32 inch in diameter. Gold, silver, and lead sheets were made to glow and ignite. Using an even more powerful battery of 274 plates which Pepys had constructed, Davy, in October 1807, was able to decompose alkalis from which he reduced potash and soda ash and extracted from them the new elements potas-



The earliest application of Volta's newly discovered source of constant-current electricity was in the decomposition of water by Nicholson and Carlisle in England and by Ritter in Germany.

sium and sodium. In the following year, 1808, a battery of 2,000 pairs of plates of zinc and copper was constructed at the Royal Institution by Pepys and with this Davy drew his most brilliant electric arc and extracted additional new elements—barium, strontium, calcium, and magnesium—from alkaline earths. He ignited cotton, sulphur, resin, and ether. Iron, quartz, sapphire, and platinum were melted, diamond evaporated, and liquids such as water and oil were boiled by the electric current. The intense heat developed by the battery was used by Pepys in 1815 to melt a short section of iron wire and diamond dust together, thereby directly carburizing the iron and thus making steel. Also associated with Davy was William H. Wollaston, trained as a physician but who abandoned the practice of medicine for the more engaging scientific investigations that intrigued him. He experimented widely with voltaic electricity and among the 38 papers which he contributed to the Royal Society were those proposing the theory that the oxidation of metals was the primary cause of the generation of an electric current in a voltaic pile. He examined spectra of the electric arc as early as 1802 and improved the form of the electric battery by exposing both sides of a zinc plate by placing the plate within the separated but adjacent faces of a bent U-shaped copper plate. In 1813, although England and France were at war, Davy traveled on the Continent with his assistant, Michael Faraday, discussing his work in Paris with Humboldt, Gay-Lussac, Count Rumford, and Ampère. He also visited several scientists in Switzerland, and Volta in Italy.

To enlarge the area of electrical investigation, a very large and effective battery was constructed by John G. Children in 1809; it consisted of 20 pairs of copper and zinc plates, each plate 6 feet long and 2 feet 8 inches wide. Children confirmed Prof. Hare's and Davy's observations that the *intensity* of the electric current increased with the number of plates whereas the *quantity* of electric flow depended on the extent of the plate surface. With this battery he rendered a bar of platinum, 1/6 inch square and 2¼ inches long, red-hot by the current. He also arranged an order of relative conductivity of metals, concluding that silver conducted the current best, then zinc, gold, copper, iron, and platinum, of least conductivity. Tin and lead were fused immediately by the current. Children, like Davy, applied current to a circuit, cutting a slot across an iron wire which he then filled with diamond powder. On passing the electric current through the circuit, the diamond turned liquid and the contiguous iron turned to steel.

An air of contentment with the record of discovery spread in England to the point where Bostock wrote, "It may be conjectured that we have carried the power of the instrument to the utmost extent of which it admits; and it does not appear that we are at present in the way of making any important additions to our knowledge of its effects, or of obtaining any new light upon the theory of its action."

In Italy one of the most active experimenters with the pile was the former pupil and colleague of Volta, the mineralogist Luigi G. Brugnatelli. He investigated the processes of plating by electricity and managed to coat two large silver medals which had been immersed in a saturated solution of chloride of gold treated by ammonia, and succeeded in covering them with a plate of gold. Credit for the clearest exposition of the chemical nature of the voltaic battery has been given to George F. Parrot, a Russian physician and a professor of chemistry at the University of Dorpat, in Estonia, whose many papers appeared in German in Gilbert's *Annalen der Physik* in 1802, 1805, 1817, and 1819.

In France, in 1808, Gay-Lussac and Thénard were provided with a battery of 600 pairs of plates which Napoleon had presented to the École Polytechnique and which was built on the pattern suggested by Cruickshank. With this battery of 1,800 square feet of metallic surface, chemical decomposition was investigated, especially of alkalis, and reported in a work of two volumes, published in Paris in 1811.

Germany, too, had its share of investigators into the action of voltaic electricity. An important contribution was made by Johann W. Ritter (1776-1810). He was the first to observe and publish, in Jena in 1800, on the electrolytic decomposition of water, and he devised the first storageable pile, which became known as a "charging" or "secondary" pile. This consisted of discs of a single metal which were separated by circular pieces of cloth or cardboard wetted by a liquid that would not affect the metal. Ritter then showed that if placed within the terminals of a voltaic pile, a portion of the electric charge would be retained and the Ritter pile would then act as a source of electric current which, like the original source, would produce electric sparks, give shocks, and decompose water. Ritter was also reported to have electrically charged a gold needle which was pivoted on its center and to have observed that the needle assumed a position of dip or deflection which remained constant after each charge. However, the angle differed from that of a magnetic needle, which assumed the usual angle of dip. Ritter's experiments, like those of other investigators of the period, seemed too uncertain or inconsistent in behavior when repeated by other experimenters and too broad in the conclusions drawn from them. They therefore received little attention in the scientific press of the time.

Another area of investigation of the performance of voltaic electricity was the distances over which the current could be made to travel. Friedrich H. Basse of the romantic town of Hameln in Hannover transmitted an electric current over 500 feet of wire suspended on fir posts along the frozen water of the moat surrounding the town. In the circuit were a voltaic battery and an electroscope which registered the circulating current. Later experiments were made across a meadow some 3,500 feet long, using the ground as the return section of the circuit.

Shortly after several experimenters first constructed voltaic piles, an additional effort was made to determine the speed of electricity in traversing an electric

An experiment in 1803 by Aldini to determine the speed of electric flow along a wire stretched across the bay at Calais, France. The indicator circuit completion was by shock to a human, or muscular contraction in a dissected animal. Although a wire return in the water is indicated, none was used.

conductor. Giovanni Aldini reported his own experiments in 1804 in his two-volume *Essai*, also the source of an electromagnetic controversy. He extended a wire between Fort-Rouge and the west jetty in the harbor of Calais. Using a voltaic pile of 80 plates of silver and zinc he completed the circuit from the pile to an overhead wire, then into a small chamber holding a dissected animal to register the electric shock when the circuit was completed. Another wire then led down into the harbor, the water carrying the current the 15 meters across to the lower terminal of the pile. His conclusion was that the current traveled with "astonishing rapidity."

To foster experimentation in voltaic currents, a society was formed in Paris called the French Galvanic Society. This group published accounts of its experiments and maintained correspondence in countries outside of France. In 1815 the Magnetic Society was founded in Paris with two distinguished scientists at its head. However, it lasted only 5 years and was concerned primarily with "animal magnetism" and the medical and psychological aspects of mesmerism.

In the United States, Robert Hare, professor of chemistry at the University of Pennsylvania, published an account of a new battery constructed in Philadelphia. Basically, this consisted of long sheets of zinc and copper contiguously rolled into coils but kept ½ inch apart. Eighty such coils were suspended by a frame which was lowered into and raised from glass vessels containing an acid solution. Investigations by Prof. Hare with this apparatus led him to the concept of "quantity" and "intensity" of the resultant electric current, depending on the number and size of the exposed plates. He thus joined Green and Hazard, other Philadelphia experimenters, in an effort to determine the chemical nature of the voltaic pile. Prof. J. R. Coxe, also a Philadelphia chemist, had proposed an electrochemical telegraph, based on the decomposition of water.

The electrochemical experiments of Davy, Berzelius, and the other chemists which led to the discovery of new earth metals, to the plating of metals by electricity and to the brilliance of the arc light, were not the only practical results of Volta's great contribution. Two additional practical uses were found for the electric current—exploding gunpowder at a distance by an electric fuse, and telegraphy, also at a distance, by the use of electric currents. Charles W. Pasley, an officer in the British Army, followed a suggestion by W. Palmer who proposed the use of a voltaic battery to ignite gunpowder by creating a spark instead of the long powder fuse which was then commonly used. Later, in 1812, Baron Paul L. Schilling, attaché to the Russian Embassy in Munich, insulated a copper wire with a thin coat of india rubber and varnish, and stretched this wire under ground and under water so as to explode powder mines across the river Neva near St. Petersburg. This was also done across the Seine during the occupation of Paris by the allied armies following the collapse of Napoleon. This demonstration of exploding gunpowder across the Seine was an astonishing sight to those who first witnessed it but did not understand the technique used.

The application of the voltaic battery as a source of energy to operate an electrochemical telegraph was tried many times during the period 1800 to 1820, but with indifferent results. The outstanding effort was the apparatus developed by Samuel T. von Soemmering,

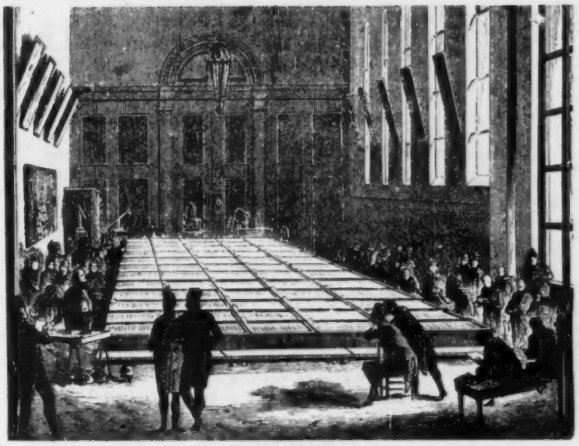
German physician, whose equipment created a considerable stir in scientific circles. In 1809, at the Academy of Science in Munich, he successfully demonstrated the telegraph over a distance of 1,000 feet. It consisted of 35 gold rods set into glass tubes placed at the bottom of a tank having glass walls and partially filled with acidulated water. To these rods were connected 35 wires wrapped in silk. These led from a wooden stand having 35 copper apertures connected to one terminal of a voltaic pile. When the other terminal was touched to the wire ends of the 35 leads (representing 25 letters and 10 figures) gas bubbles would rise in the distant tank and would so indicate which letter or figure was being transmitted. Albeit slow and clumsy, still this was a working mechanism and was greatly admired. General Larrey, Napoleon's chief surgeon, carried Soemmering's telegraph to the French Academy of Sciences where a committee of outstanding physicists studied and rendered a report on its operation. In the 2 subsequent years Soemmering reduced the number of wires required for the telegraph to 27 and in 1812 the distance of its operation was extended to nearly 2 miles.

Further improvements in this form of electric telegraph were suggested in 1811 by Johann S. C. Schweigger (1779-1857) who recommended the reduction of the many wires to simply two conductors by the use of two voltaic batteries of unequal power. The combination of these three elements could, Schweigger held, provide the needed combinations to transmit all the letters and figures, by using longer or shorter periods of gas generation. He also recommended the use of a pistol triggered by the battery to signal the beginning of a message, instead of indications by an accumulated gas, such as Soemmering used.

The search for a relationship between voltaic electricity (referred to in that period as "galvanism") and magnetism was investigated by many component experimenters during the period 1800 to 1820. Especially noteworthy were the investigations made in 1805 by Hachette and Desormes. They constructed a battery of 1,480 thin copper plates coated with zinc, and this pile was set on a float resting on the water in a large vat. No orientation with the earth's magnetic field was observed, although a steel bar magnet which weighed nearly half as much as the pile itself, and was also floated like it, moved in a series of oscillations until it rested in the magnetic meridian. It was noted that the poles of the pile were not joined during the experiment. Another effort to link electricity to magnetism was made by Johann P. Prechtl of Trieste and the Vienna Polytechnic Institute in 1810. However it was found that his exposition of diagrams and mode of reasoning proved too complex to impress his readers.

THE ELUSIVE FORCE

A REVIEW of the 20 years following the discovery of voltaic electricity clearly shows a continued and intense interest in almost every phase of investigation made possible by the introduction of a source of constant-current electricity. The chemists were exceptionally busy theorizing and experimenting to determine the physics and chemistry of electric generation. Although many corollary effects and physical manifestations of the electrical and electrochemical experiments were investigated, what seems to us now as a most obvious relationship—the magnetic effects of an electric current—seems to have been missed. When we hunt for the clear and specific observation (inevitably to be made by some keen investigator), it may seem incredible that it should have required 20 years of experimenting and observing finally to present that fact in complete clarity. Thus, we see that Nicholas Gautherot (1753-1803) a French chemist, had observed as early as 1801 that two wires, one connected to one end of an electric battery and the other to the other end, would tend to adhere to one another when these two wires were brought in close contact. Not only was this observation repeated in 1806 by such experimenters as C. J. Lehot, a French physicist, but the phenomenon was independently observed by both Laplace and Biot.



The powerful voltaic battery constructed at the Polytechnic Institute in Paris in 1813 by order of Napoleon who showed exceptional interest in the development of electricity.

The report of Romagnosi, whose experiment is described later on, and others even less specific in associating magnetism with electricity had negligible effect on the many investigators. The impact of Oersted's great discovery and announcement is in sharp contrast with the uncertain trials, hints, and suggestions of the earlier experimenters.

On July 21, 1820 there appeared a 4-page notice in Copenhagen, in Latin, announcing Oersted's discovery of electromagnetism. This literally electrified the entire scientific world. As rapidly as word could be gotten from mouth to ear, by traveler or visitor, in private conversation or in the lecture hall, the substance of what Oersted's short announcement contained was spread. The physical world and man's institutions could never again be the same, now that Oersted presented the first rich fruit of Volta's epochal discovery.

(The second article of the series will appear in the June issue.)

Automation and Mankind

V. A. TRAPEZNIKOV

A broad view is presented of the road being opened to mankind by the rising influence of automation on the animate and inanimate sciences. Automation is effecting radical changes in the very nature of labor; such crucial problems as the origin of life, the fate of the earth as a planet, extraterrestrial life, are being solved with its aid. An imposing future is predicted—provided there is peace.

FOREWORD

A. N. KOSYGYN

Quite recently, only 20 to 30 years ago, automatic control was considered as just one of the many means for developing technological processes, having only a limited, partial importance. Even the words "automatic control," and "automation" did not appear at that time on the pages of the world press, with the exception of the Soviet press, but in the early forties the position utterly changed. Automatic control is now recognized throughout the world as a new, young, independent branch of science and engineering, as one of the most powerful levers of modern technical progress. More than that, automatic control enters the world's arena and takes by right, on account of its importance, an equal place in the field of science with new techniques such as nuclear energy, radio-electronics, and astronautics. This can be explained by the enormous possibilities provided by automatic control for the development of modern techniques. Complex mechanization of production, by releasing man from heavy physical labor and replacing his work by that of mechanisms and machines, increased productivity and prepared the ground for the following higher stage—the complex automation of production. Complex automation of production already releases men from control operations pertaining to the field of intellectual brain work. Modern automata are able to relieve men in many instances from brain activity and, therefore, enable him to economize his forces for the creative process.

Automation leads to a further fundamental increase of productivity and allows man to bring into effect processes characterized by high speeds and intensities which were unattainable before on account of the limitations of human nature. However not only quantities should be considered. Complex automation already has made an important impact on social, economic, and political areas. Automation, by increasing productivity, contributes to a marked increase of material wealth and to a solution of the problem of a substantial increase in the standard of living of mankind. Automation contributes to the obliteration of the frontiers separating brain work from physical labor, creating a basis for an unusual cultural flowering and an increase of the intellectual level of the average man. Concern is sometimes expressed that by releasing an important amount of labor, automatic control would lead to a decrease of occupation and to serious difficulties connected with redistribution of manpower among various branches of production as well as among various territories. Some experts and politicians already perceive behind these consequences of automation two threatening shadows, those of overproduction and of unemployment. But abundance cannot be an evil if production and distribution and all the economic, cultural, and social life of society are built on a well-organized, planned basis and managed according to a peaceful direction. This is why we, the Soviet people, as well as people of other countries having reasonably organized economies, do not fear the consequences of automation and do our best to develop it strongly.

It is very significant that the first International Congress of Automatic Control (IFAC) takes place in the USSR, a country which is successfully developing automated production, a country in which automation is accomplished as a state policy. It is not accidental that in the USSR, for the first time in the world, the review *Avtomatika i Telemechanika*, specially devoted to this field of science, was first published in 1936, and that we have created, also for the first time in the world, in 1939, under the leadership of the Academy of Sciences of the USSR, a special Institute of Automatics and Telemechanics, one of the most active organizers of the present Congress.

Let me express the certainty that this Congress will contribute to a fruitful exchange of experience between scientists and engineers of various countries, to the establishment of friendly contacts between them, and to a further peaceful development of industry, of energy production, of transportation, and of all aspects of the life of mankind.

THIS Congress has been convened to discuss problems of automatic control or, more widely, of automation.

It is pertinent to ask what the over-all goal of automation is? What can automation give humanity? Be-

Essentially full text of the introductory remarks of a Soviet Government official and the speech of a Soviet delegate to the First International Congress of the International Federation of Automatic Control (IFAC) held in Moscow, USSR, June 27-July 2, 1960.

A. N. Kosygyn is vice-premier and first vice-president of the Council of Ministers of the USSR.

V. A. Trapeznikov is director of the Institute of Automatics and Telemechanics, Moscow, USSR.

fore we can answer this question, let us picture to ourselves the likely fruits of automation and trace the effect of automation on man in the foreseeable future.

First and foremost, automation spells a steep rise in labor productivity. Of course, automation is by no means the only factor contributing to scientific and technological progress which results in higher labor productivity and expanded production of the good things of life. A big role here will be played by advances in controlled fusion, synthesis of man-made organic substances including foods, and in the multitude of other sciences and branches of technology. However, all departments of knowledge today are knitted together closer than ever before, and their further headway is inconceivable without automation. To cite but a few examples, man owes to automation his space prowess, photographs of the moon's reverse side, and the very existence of powerful means of research such as the proton synchrotron.

But automation is still an infant. It will rise to maturity in the life-span of generations to come. What we can do now, therefore, is to outline its benefits for man in general terms only.

Automation will bring in its wake a big leap in productivity not only because man will not have to operate machines by hand and a single operator will be able to attend to many automatic units at a time. What is more important is that the expansion of production will no longer be constrained by the human factor in process control.

In many cases today, the rate of industrial processes is restricted by the potentialities of control. Man's response to environmental changes is rather slow. This is why we can only use slow processes.

Automation will revolutionize the majority of manufacturing techniques, as it will provide for control of industrial processes which occur at extremely high rates and on a large scale. While our practice to date has been confined to stable processes, automatic control will place unstable processes at man's disposal as well. Man will be able to control both the outcome and kinematics of reactions.

Atomic energy is but one example of how an effective control system has enabled man to utilize extremely dangerous phenomena to the best advantage. With absolute confidence in automatic instrumentation, it will be possible to maintain processes as close as possible to critical operating conditions. As a result, use will be made of the processes which seem to be beyond man's control today.

The goals of automation can only be achieved when all steps of the industrial process have been automated in all basic industries, transport, and building, including the assembly, adjustment, inspection, shipment, and distribution of the finished product, that is, when comprehensive automation has been realized to cover ramified remote-control systems widely using computers.

It stands to reason that man cannot possibly be excluded from this process entirely. Supervision, maintenance, research, and development will always call for his more or less regular attendance. It is beyond any shadow of a doubt that man's potentialities in the field of control are great indeed and will never, it appears, be fully surpassed by machines. Therefore, it is the foremost and noble task of scientists in the field of automatic control theory, physiology, psychology, and technology to find the best possible uses for man in control systems and to create the best possible conditions for man's activity in process control.

MENTAL WORK DISPLACING MANUAL LABOR

Not only will automation raise productivity, but it will also radically change the very nature of labor. A number of arduous and hazardous occupations have already almost completely been done away with, and the trend will continue. In many cases one can no longer see the stocker doing his exhausting job, while those of the steelmaker and blast-furnace operator have become appreciably easier to do. Looking farther into the future, automation will completely take over jobs involving elevated temperatures and pressures, contaminated or harmful atmospheres. Automation will help turn manual labor more and more into mental work, thus removing the difference between them, so that man's energy and vital strength directly involved in production may be utilized to an ever greater degree not for process control or, less so, for manual labor, but to produce and realize novel engineering ideas, such as would further relieve man of direct participation in production and would give him abundant life and more leisure.

The higher labor productivity and expanded material production stimulated by automation will sharply improve the standards of living and reduce the working day to but a few hours in the near future.

The full utilization of the benefits arising out of automation, however, is only possible in a rationally organized society where the manpower made redundant due to automation in one field is easily absorbed in others. Our firm conviction—which we do not, of course, impose on anybody—is that this possibility is offered by the socialist system.

With increasingly more material benefits available due to automation, a smaller proportion of people will be needed in production. A larger number of them will be concerned with research and development, public health and the arts, making our communities better places to live in by laying out parks and gardens, decorating public buildings, and so on.

With more leisure time, means, and possibilities at his disposal, man will be able—for the first time in history—to devote to himself the attention he rightly deserves. An era will set in of a scientific approach to human health, with emphasis on balanced daily regimen and diet, sports and prophylaxis. Medical and biological sciences will be given priority to the point where the main duty of the physician will be that of prophylaxis and every case of disease will be regarded as an emergency. Automation's important contribution to medicine will be automatic and semi-automatic ap-

paratus to watch the patient's health, keep his case history, diagnose and treat his ailments.

KEY PROBLEMS APPROACHING SOLUTION

AUTOMATION OPENS UP vast vistas before science. The spectacular breakthrough into outer space is the case in point. Indeed, progress in automation is a decisive factor in manned space travel which, I believe, this generation will live to see. In turn, the breakthrough into space is bringing about rapid headway in our knowledge of many crucial problems which have been challenging men of science for centuries. The origin of life, extraterrestrial life, the fate of the earth as a planet —all these and other problems which have always been on the mind of man are approaching their solution thanks to space research and, hence, to automation.

Mention should also be made of biology or, more specifically, of control in living organisms. These problems closely relate to that of the origin of life. Automation will undoubtedly speed up their research. In turn, automatic control systems stand to benefit much by investigations into living beings.

Automation is changing the forms and techniques of research in many departments of science and technology. The very process of cognition is being speeded up. Our knowledge is growing in a kind of chain reaction. The more we learn, the wider the horizons and prospects in front of us, the ampler opportunities for further progress of research, discoveries and knowledge. This, however, poses further difficulties. For one thing, it is becoming increasingly difficult to store the huge wealth of information and to transmit it in concise, condensed form. On the other hand, it is becoming increasingly difficult to glean new data, to carry on new studies, as science is ramifying at a high pace. Whatever we look at—numerous experiments on alternative chemical reactions made to find unknown properties of chemical substances, studies into the living cell, investigations into conditioned reflexes, research into economic and other complex problems—takes a heavy toll of human effort, and of skilled effort, for that matter. In the future, human work will be substantially supplemented and partially supplanted by automatic machines. Automatic systems with minimum a priori information put into them by the designer will collect information in new fields of knowledge. The researcher is already equipped with a variety of measuring, recording, and computing machines. In the future a veritable research industry will emerge, based on specialization, co-operation, and use of machines.

The automatic machines helping the investigator can be self-learning. They may learn simple skills for limited assignments. In fact, it is not impossible in principle to make them acquire "creative" skills, that is, improve automatically for their performance in complex fields. Today, no limits can be forecast for the development of such systems. It is not in the least unlikely that an automatic machine may be designed which will be able to work out comprehensive theories explaining experimental information in any field by testing various hypotheses and drawing upon empirical knowledge. And this is what we call today truly creative activity!

This faculty, of course, belongs not to the automatic machine, but to man who has designed it. You cannot possibly conceive of an automatic machine divorced from man. Any machine, including automatic, is but the brainchild of man. But the machine can help man in his brainwork by extending and raising it to a level which defies our imagination.

Electronic computers have shown how far man can rely on them for the performance of operations based on formal logic. Indeed, it has been a kind of revelation for specialists to find out how wide the field of formal logic extends and how complex the processes are which hitherto were the domain of the human brain, but which now lend themselves to automation with the advent of digital machines.

Machine translation and programming of problems which would seem to belong to the human brain, such as chess problems, have convinced many that formal logic, that is, thinking which can be programmed, is much wider in scope and plays a far bigger role than it was customary to believe. Where do the limits of such possibilities lie? How wide is the field of brainwork which can be handled by automatic machines? Is this field limited to processes which can be reduced to an algorithm, or does it extend far beyond? We take an optimistic view of such things and hope that automation holds an unlimited promise as a helper of man in his mental activity. In effect, automation plays a noble role here, for it is relieving the human brain of routine work on an ever larger scale to offer man inexhaustible opportunities for creation and aesthetic endeavors.

PROBLEMS FACING AUTOMATION

THE GOAL OF AUTOMATION is a noble one. It is realistic and feasible. But there are a number of obstacles to clear and a number of formidable problems to solve before it can be achieved.

For all of the big strides in the individual departments of automatic control theory, the over-all picture of the theoretical aspect leaves much to be desired. For one thing, there exist a multitude of isolated theories not integrated into a single comprehensive theoretical structure. The all-embracing fundamental ideas, methods, concepts, and laws are still in the making. Secondly, a number of conceptual problems have not been studied at all. Gaps in control theory are particularly striking when attempts are made to study complex systems with abundant elements and relationships between them. In fact, the very approach to such problems is not yet clear. On the other hand, it is such systems that are most promising, for they simulate certain complex functions of man.

It should be noted further that the theory of automatic control is gradually changing its nature. It is rising to the status of the key factor in automation. While in the recent past the theory was primarily incidental to automatic control engineering, at present it is, and will be in the future, assigned an ever bigger

role. Indeed, the theory shapes the scientific outlook of the engineer and guides him in search of fundamentally novel systems. On an ever larger scale the theory is being employed for "strategic reconnaissance" so as to find out what machines can or cannot do and how their potentialities can possibly be extended.

Let us dwell on a few major scientific and engineering problems facing automation at the present stage of development.

1. We cannot possibly underestimate the importance attached to the study of optimal control techniques and to the synthesis of control structures approaching the optimal.

This range of problems is extremely wide. Indeed, the controlled plant can be either linear or nonlinear, with lumped and distributed characteristics, continuous-time and discrete-time. Performance criteria can also be as diverse in different cases. Systems can be optimal for settling time, for steady-state accuracy, for average productivity, for efficiency, for power consumption, for material consumption, and the like.

There exist, at present, general variation principles, such as the maximum principle and dynamic programming, which may provide a basis for the solution of very complex problems. But, not all of these principles are generalized for other important cases. Moreover, their application to actual problems calls for the solution of further complex theoretical problems. Little headway has as yet been made in the synthesis of simple systems approaching the optimal. In short, there is much room for progress here.

2. It is just as important to study the principles underlying the synthesis of adaptive and self-learning systems.

The addition to control systems of sophisticated logic and memory elements has made it possible to handle a far wider range of control problems. These problems involve the establishment and maintenance of the best possible performance of the plant, the gradual development in controllers of the desired responses to complex varying situations, etc.

Much progress has already been made in this field. We in the Soviet Union have developed optimal controllers and multivariable optimizers for both commercial and laboratory applications. Substantial progress has been made in the design of self-learning automata. These are but initial efforts in an important domain.

The study of principles involved in the design of automatic systems which handle such problems, as well as their theory and calculation, are among the most urgent tasks facing automatic control theory.

3. It is also essential to study the principles governing the design of automatic machines which supplement or supplant the human design engineer.

It is often the case that man fails to produce the best possible result, if any, when a given design problem involves mechanical structures with a large number of elements. This is where the automatic machine may play a key role. Unfortunately, the theory covering this field is still in embryo, and there is even lack of understanding of relevant design principles. Perhaps, support here may come from co-operation with physiologists and psychologists and from studies of the manner in which man handles similar problems. Though rather inaccurate and slow, these methods are remarkable—compared to the existing automatic machines—for flexibility and adaptability to most varying problems, for their "intuition," "imagination," and the faculty of analogy and generalization. It is in this field that automatic control theory comes closest to cybernetics of which it is, strictly speaking, the engineering branch. The possible theory in this new and intriguing field of complex automata may crystallize into a unique alloy of theoretical logic, statistics, and perhaps calculus of variations. It is not unlikely that entirely new approaches will emerge to the treatment and solution of problems. Our duty is to speed up progress in these directions in every possible way.

In the Soviet Union, there is a large number of investigators working in this field. A whole range of devices has been developed for the automatic synthesis of optimal control systems, as well as a machine for relay system analysis. The first such machine has been engineered for the structural synthesis of relay elements, a machine which starts from the set conditions to produce the structure of a given relay element on an illuminated screen in graphic form. Work is nearing its completion on a machine which will minimize Boolean functions. However, these are but the first steps toward the complete automation of control system synthesis.

It stands to reason the directions mentioned here do not exhaust possible trends, for we are faced with a number of other urgent problems—stability, control performance, decision problems, integrated system theory, etc. There is a strong interdependence among them all, an interdependence which is to grow stronger in the future. As our problems grow in complexity, closer ties have to be built between automatic control theory and other sciences. Mention has already been made of co-operation with physiology and psychology. Ties should also be noted with mathematics, especially with theoretical logic, variational, and statistical methods. Other more recently developed mathematical departments, such as functional analysis, may also find essential applications in the theory of automatic control.

Advances in engineering and science are laying a single theoretical foundation for the whole range of engineering subjects involved in communication and control: automatic and remote control, radio and electronics with all their ramifications, computer engineering, etc. This comprehensive theory which is still in the making is often called either communication and control theory, or control theory, or engineering cybernetics. However, the name is not essential. What is important is the crystallization of fundamental ideas, principles, and methods. The development of this single theory is vital to automation.

No progress of automatic control theory and engineering, however, is possible without commensurate advances in automation hardware. It has always been that every new device and every new physical principle embodied in its structure has given rise to quantitative changes, to further headway of automatic control theory. This can be exemplified by the impact the advent of electronic computers, both analog and digital, has had on automation and automatic control theory.

In the field of automation hardware, there are both considerable achievements and numerous gaps—problems which are still waiting for their solution.

The most important among them is that of reliability. For, as the range and complexity of problems handled by automatic control devices increase, an ever larger number of elements have to be incorporated in a given control system, which fact raises the failure expectancy rate. Add to this the continuous intensification and growing scale of processes as well as the outcome of possible breakdown, and you will clearly see that the problem of reliability is a key one. In fact, it poses before automation Hamlet's dilemma—to be or not to be. Two approaches are possible to this problem: (1) developing more reliable components and improved techniques for their combination; and (2) seeking methods which would allow unreliable components to be integrated into reliable systems.

Another crucial problem in the field of automation hardware is that of unitized control systems which are made up of standardized units which can be combined into various packages suitable for a given plant. This technique simplifies the design, manufacture, and operation of automatic control systems and reduces the over-all cost of automation.

And last but not least, there is a third important problem in the field of automation hardware. What we have in mind is microminiaturization, that is, the development of microelements. This problem has been brought to life by the increasing number of elements in control systems and by the reliability requirements.

This trend is aptly exemplified by digital electronic computers. Huge mathematical machines using thousands of electronic tubes are giving way to machines based on semiconductors and magnetic elements. But the new stage is by no means the final one. Already there is strong indication of the imminent changes. The new types of computers may be based on novel physical principles. Their components will be magnetic tapes, cryogenic devices, etc. Some of them will be able to perform operations within a few nanoseconds and will be very compact in size. It is quite feasible to develop a micromodule which will hold many thousands of memory elements in one cubic centimeter. The new elements will be extremely reliable, partly due to new manufacturing techniques, partly due to novel packaging procedures. Among them are films deposited in vacuum, printed circuits for connections inside and between units, etc. The progress made in this field is particularly striking in the Western countries.

It may also so happen that the traditional automatic elements will appear in new capacities. Incidentally, as some Soviet investigators have found, quite unexpectedly, the conventional pneumatic devices can be integrated into entirely novel control systems which depend for their operation on the interaction of air jets. They allow a wide range of control systems to be constructed, including high-speed extremely reliable digital computers for process control. This trend, it appears, will revolutionize the design of many automatic control systems.

There is another important problem which unfortunately is outside the scope of this Congress, though it has a decisive effect on automation. This is the study of industrial processes, basic process equipment, and automatic control systems taken as an integral whole. As we believe, it is only this approach that can provide for a qualitative jump in the efficiency of automated installation or plant. It is only this approach that allows all the advantages of automation to be utilized to the utmost. We in Russia have taken this road.

PROGRESS RESTS ON CO-OPERATION

IN CONCLUSION, I would like to touch, if only in passing, upon the planning of scientific effort and research. Of course, the optimal decision problem as applied to the planning of research and engineering does not and cannot have a hard and fast solution. However, what experience is gained in the field makes it possible—in general terms—to solve the key problem: that of correlation between applied research subordinated to the interests of the present day, and fundamental research which deals with the major problems of the future. It is absolutely clear that the role of fundamental or basic research is bound to grow with time, and its scope should be extended. This is the prerequisite for the true progress of science and engineering. On the other hand, the wider the scope and the bigger the role of fundamental research, the more difficult it is to organize. How can we possibly prevent an investigator mistaking a byroad for the highway and ending up in a blind alley? How can we possibly reduce the drain of effort and time involved in trials and errors in a multitude of unknown domains? Leaving out other considerations, it may be said that much will depend here on contacts and the exchange of information between scientists and engineers in various fields and various countries. The closer their co-operation, the smaller the drain of effort on hopeless projects, the clearer the outline of the major trends, and the steadier the progress of research. This is what is necessary.

The prospects of progress before humanity are imposing. And advances in automation and automatic control theory are part of the general progress. The avalanche-like and ever-accelerating headway of mankind can only be impeded by the monstrous and insensate catastrophe—war. We are confident that this catastrophe will not break out, for the nations will avert it. Peace is the vital prerequisite for the prosperity of man, for the development of science, for the progress of automation.

Digital Calculation of Transmission Line Impedances

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TWO PROGRAMS for the IBM *650* digital computer have been developed by the Detroit Edison Company for computing the symmetrical component impedances of 3-phase 60-cycle open-wire transmission lines. One program obtains the data for a complete line with due consideration for any changes in configuration from tower to tower; the other obtains the data, on a "per mile" basis, for a fixed configuration. Fig. 1 is a

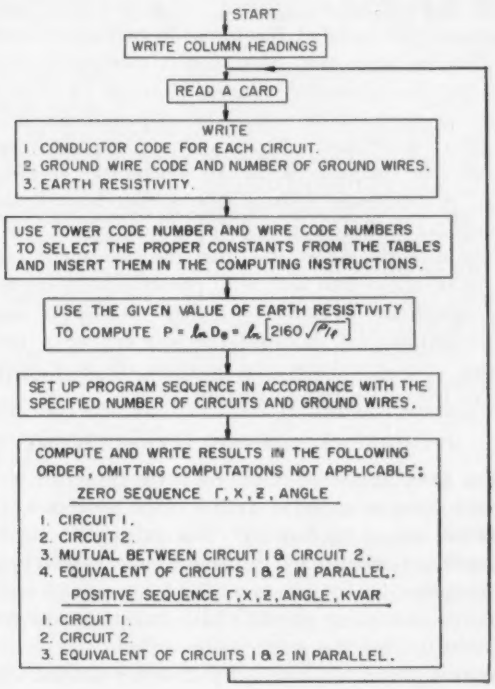
START
WRITE COLUMN HEADINGS
READ A CARD
WRITE
1. CONDUCTOR CODE FOR EACH CIRCUIT.
2. GROUND WIRE CODE AND NUMBER OF GROUND WIRES.
3. EARTH RESISTIVITY.
USE TOWER CODE NUMBER AND WIRE CODE NUMBERS TO SELECT THE PROPER CONSTANTS FROM THE TABLES AND INSERT THEM IN THE COMPUTING INSTRUCTIONS.
USE THE GIVEN VALUE OF EARTH RESISTIVITY TO COMPUTE P = ln De = ln [2160 √ρ/f]
SET UP PROGRAM SEQUENCE IN ACCORDANCE WITH THE SPECIFIED NUMBER OF CIRCUITS AND GROUND WIRES.
COMPUTE AND WRITE RESULTS IN THE FOLLOWING ORDER, OMITTING COMPUTATIONS NOT APPLICABLE:
ZERO SEQUENCE Γ, X, Z, ANGLE
1. CIRCUIT 1.
2. CIRCUIT 2.
3. MUTUAL BETWEEN CIRCUIT 1 & CIRCUIT 2.
4. EQUIVALENT OF CIRCUITS 1 & 2 IN PARALLEL.
POSITIVE SEQUENCE Γ, X, Z, ANGLE, KVAR
1. CIRCUIT 1.
2. CIRCUIT 2.
3. EQUIVALENT OF CIRCUITS 1 & 2 IN PARALLEL.

Fig. 1. General block diagram, single-tower impedance program.

block diagram of the "per mile" program. Limitations on the programs are:

1. Lines are assumed to be fully transposed.
2. Towers carry no more than two circuits.
3. Each circuit has only one conductor per phase.
4. Each tower may have no ground wires, one ground wire, or two identical ground wires.

Digest of paper 60-1391, "Digital Programs for Calculation of Transmission Line Impedances," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Power Industry Computer Application Conference, St. Louis, Mo., Nov. 9-11, 1960. Published in AIEE *Power Apparatus and Systems*, Feb. 1961, pp. 1229-35.

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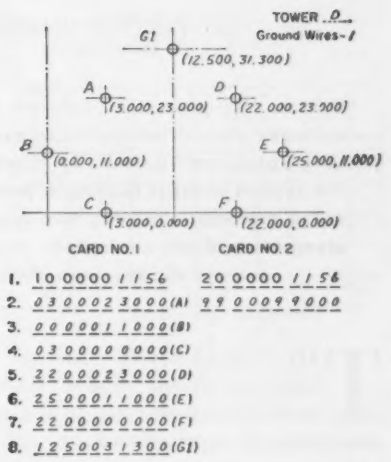

Fig. 2. Typical input data format for auxiliary program.

5. Ground and ground wires are ignored in the calculation of positive-sequence quantities.
6. Height above ground is ignored.

The programs compute the following data:

1. Zero-sequence and positive-sequence resistance, reactance, impedance, and impedance angle.
2. Total 3-phase positive-sequence charging kva.

Both of the programs are based on the use of a table of "tower constants" which is prepared by an auxiliary program. The tower constants are those functions of conductor spacing at a tower which recur frequently in the various formulas used for computing the impedances. Once obtained, the table of constants can be used for any desired conductor combinations. In the preparation of data for the auxiliary program, conductor locations at a tower are specified by means of an *X-Y* co-ordinate system. The *X* axis is drawn through the lowest conductor on the tower and the *Y* axis is drawn through the leftmost conductor. Towers are identified by 4-digit code numbers. Fig. 2 illustrates data preparation for the auxiliary program.

By the establishment of a "tower card" file, the systematic calculation of line impedances can be facilitated. A line can be represented by a deck containing one card for every tower. Changes in a system can then be studied by rearrangement of decks. New cards can be added, for line extensions or cards can be removed when part of a line is removed. The effect of conductor or ground wire changes on existing towers can easily be found by machine reproduction of a deck with the new conductor codes replacing the old. Changes in tower dimensions require a run on the auxiliary program in order to obtain the new tower constants.

Surge Protection of Low-Voltage D-C Circuits

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Devices for protection against transient overvoltages should reduce these overvoltages to a safe value well below the breakdown level of the system without causing a power outage. D-c surge protectors utilizing two types of switching elements—silicon-controlled rectifiers and 4-layer diodes—are discussed.

THE INCREASING USE of solid-state devices, such as silicon diodes, transistors, silicon-controlled rectifiers, etc., in d-c systems has posed a new problem of protection against transient overvoltages, because the transient voltage withstand capabilities of these solid-state devices have very little margin above the steady-state rated voltage level. Therefore, it is of value to be able to apply these devices on the basis of steady-state voltage ratings and to protect them against transients overvoltages by suitable surge protectors.

Protection of a system against transient overvoltages, such as those caused by lightning and switching by surge protectors, requires that these protectors be able to reduce the transient overvoltages to a safe value well below the breakdown level of the system without causing a power outage. Therefore, a surge protector has three duties to perform:

1. It should be able to "switch on" in response to a transient overvoltage, so that the insulation of the protected system is not stressed beyond a safe value.
2. It should be able to "switch off" the power-follow current within a reasonably short period afterwards so that a system outage is prevented.
3. It should be able to perform the first two duties repeatedly without being damaged.

A typical valve-type a-c protector consists of a calibrated gap in series with a nonlinear resistor. During normal system operation, the nonlinear resistor is isolated from the line by the gap. However, the gap sparks over at a preselected voltage level by a transient overvoltage, thus connecting the nonlinear resistor directly across the line or the apparatus to be protected. The nonlinear resistor offers very low resistance to a high voltage and high resistance to a low voltage. Therefore, the surge voltage is diverted very easily. Once the surge is absorbed, the system current, known as the power-follow current, flows through the already conducting gap. However, because of the nonlinear characteristic of the resistor, the power-follow current is arrested as the system voltage passes through zero. Obviously, an a-c surge protector utilizes with advantage the cyclical nature of the alternating voltage.

For low-voltage d-c systems, capacitors, nonlinear resistors, or the parallel combination of both have been applied for surge protection. Capacitors are quite effective for short-duration surges. However, a very high value of capacitance would be required for a long-duration surge and, theoretically, a capacitor would double the magnitude of an oncoming rectangular surge. A nonlinear resistor would effectively limit the voltage across the protected apparatus; but if it is connected directly across the line, the nonlinear resistor would be a constant source of power loss. A calibrated gap connected in series with the nonlinear resistor seems impractical, because the absence of a natural voltage zero in a d-c system prevents the easy interruption of the power-follow current.

METHOD OF SURGE PROTECTION STUDIED

THE BASIC ELEMENTS of the d-c surge protector studied are the same as those in an a-c surge protector; i.e., a diverting circuit consisting of a calibrated switching device in series with a nonlinear resistor. However, the power-follow current is quenched by means of an additional commutating circuit which interrupts the diverting circuit after the surge is dissipated.

As this study was primarily directed toward 200- to 400-volt circuits, the selection of a suitable switching element created a real problem. This element should have very little variation of the breakover (or switching) voltage, and in the ideal case it should also be independent of the rate of rise of the applied voltage. As no low-voltage gap satisfying the above two conditions was available, the following two devices were investigated: (a) the silicon-controlled rectifier (SCR)[1] and (b) the 4-layer diode.[2]

SURGE PROTECTOR USING AN SCR

A SILICON-CONTROLLED RECTIFIER is a p-n-p-n device[1] with a third electrode, called the gate, connected to the inner p-layer as shown in Fig. 1. An SCR does not conduct when a voltage less than its forward breakover voltage is applied in the conducting direction. However, if a small positive pulse of current is passed from the gate to the cathode, the SCR conducts and keeps on conducting even after gate excitation is removed. In

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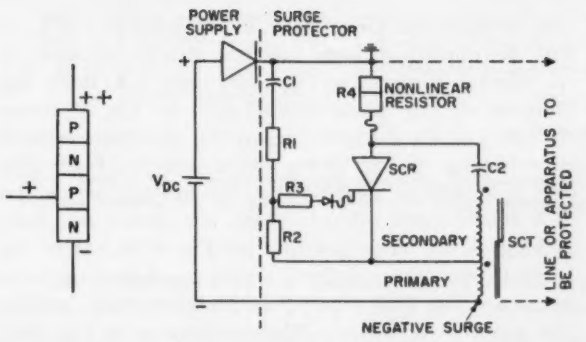

Fig. 1 (left). Schematic representation of an SCR. Fig. 2 (right). Surge protector with Morgan circuit.

R1, 2,500 ohms; *R2*, 200 ohms; *R3*, 100 ohms; *R4*, two GE *3900T57G1* Thyrite resistors in series; *C1*, 0.02 μf; *C2*, 0.5 μf; *Vdc*, two 45-volt batteries in series; *SCT*, *5233D1* (Arnold Silectron tape-wound core); primary winding, 5 turns; secondary winding, 20 turns.

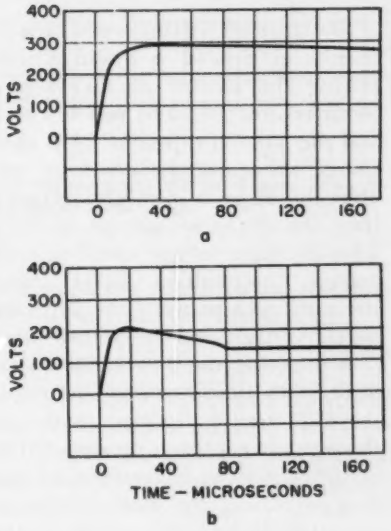

Fig. 4. Applied surge to SCR-type surge protector (Morgan circuit). Voltages measured with negative bus as reference. (a) Without surge protector. (b) With surge protector.

this conducting state, the voltage drop across anode to cathode is in the neighborhood of 1 volt for all currents. In the nonconducting or blocking state, only a small leakage current would flow for all allowable voltages. The SCR can be restored to its blocking state by reducing its anode-to-cathode current to less than the "holding current" value. This is accomplished if either (a) a reverse voltage is applied between the anode and the cathode or (b) a high resistance is placed in series with the SCR. Therefore, associated with an SCR, there must be an "on" circuit to switch it on and an "off" circuit to switch it off. In the surge protector utilizing SCR's, only one type of "on" circuit was studied with different types of "off" circuits.

Turn-On Circuit. The "on" circuit (Figs. 2 and 3) consists of a resistance voltage divider connected across the line to be protected. The voltage across the lower arms of the voltage divider *R2* is fed between the gate and the cathode of the SCR through a current-limiting resistance *R3*, a fuse, and a silicon diode for protection of the gate against reverse voltage. Therefore, by selecting the voltage-divider ratio, the SCR can be turned on at any preselected voltage level. A small capacitor *C1* is connected in series with the voltage divider to prevent the system direct voltage from appearing across the gate of the SCR. On switching the d-c power, a transient may be passed through this capacitor, the gate excited, and therefore the SCR may go into conduction. However, the turn-off curcuit would turn the power off eventually without causing a system outage. Therefore, by using this blocking capacitor, the voltage-divider ratio may be chosen so that the gate can be excited by a very small external transient voltage without in any way being affected by the d-c power source. This permits adjusting the gate circuit for high sensitivity, and consequently makes the protector sensitive to small surges. However, the gate sensitivity should not be increased indefinitely. If the switching voltage is made lower than the discharge voltage (i.e., the voltage drop across the nonlinear resistor) and the surge protector, the system protection level will be determined by the discharge of the surge protector and the advantage of a lower switching voltage would be lost. Therefore, the gate sensitivity should be such that the switching voltage and the discharge voltage of the surge protector are about equal.

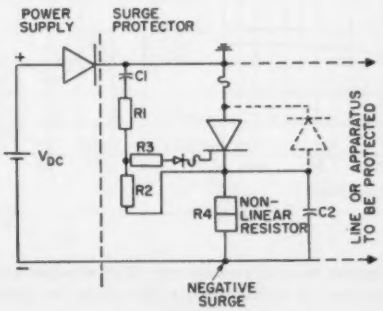

Fig. 3. Surge protector with nonlinear resistor and capacitor in parallel. (Component values same as in Fig. 2.)

Turn-Off Circuit. Two different turn-off circuits were studied, using (a) the Morgan[3] scheme and (b) a parallel combination of capacitor and nonlinear resistor.

The Morgan scheme of turn-off circuit is shown in Fig. 2. Under normal system operation, the capacitor *C2* is charged by the system voltage with the upper plate positive. After the SCR is made to conduct by the transient overvoltage applied to the resistance divider and gate circuit as described earlier, the current flow through the primary of the saturable current transformer SCT will induce current in its secondary in the direction first to discharge the capacitor *C2* and then recharge it in the opposite direction (lower plate positive). The current through the secondary stops after the capacitor *C2* has been fully charged and the saturable current transformer eventually saturates due to current flowing only in the primary. Once the saturable current transformer is saturated, the charged capacitor *C2* is placed directly across the SCR with positive voltage on the cathode of the SCR. Therefore, the SCR blocks. Fig. 4 shows the applied impulse voltage with and without the surge protector.

The turn-off circuit with capacitor and nonlinear resistor in parallel is shown schematically in Fig. 3. During the passage of the surge current, the nonlinear resistor *R4* offers very low resistance to the surge and the parallel capacitor *C2* is charged up to the discharge voltage of the nonlinear resistor. Immediately after the surge is over, the voltage of the capacitor is then the discharge voltage of the nonlinear resistor. This discharge voltage would be higher than the system voltage. The resultant voltage across the SCR would be the difference between the capacitor voltage and the system voltage, and this voltage would be in the direction opposing the flow of system current through the SCR. With time, however, the resultant voltage across the SCR would decrease, as the capacitor discharges through the nonlinear resistor. But the resistance of the nonlinear resistor increases as the capacitor voltage falls, thus increasing the time constant of discharge of the capacitor. This would prolong the reverse voltage across the SCR, which would revert to the blocking state during this interval.

Fig. 5 shows the open-circuit applied voltage, the voltage across the surge protector, and the voltage across the silicon-controlled rectifier. It should be noted in these oscillograms that the zero of the waves as marked by the zero line is shifted upward by the voltage across the SCR in its blocking state. In other words, the actual zero-volt line lies below the zero line on the oscillograms and so the oscillograms show only the transient voltages. Fig. 5(c) shows that the voltage across the SCR (the anode with respect to the cathode) is the same as the applied voltage until the SCR switches on. Then, after some oscillations, the voltage across the SCR falls to its forward drop (approximately one volt), indicating the conducting state of the SCR. However, just after the switching and before the full conducting state begins, the anode is driven transiently negative with respect to the cathode, because of the fast switching action. At times, this negative voltage could exceed the peak reverse voltage (PRV) rating of the SCR and, as a consequence, it could be damaged. To protect the silicon-controlled rectifier against such overvoltages a silicon diode was connected back to back to the SCR, as shown by the dotted lines in Fig 3. This back-biased diode has the additional advantage that it also protects against a surge of opposite polarity, as will be explained later in this article. Because of the shorter time scale, Fig. 5 (c) does not show the blocking of the power-follow current. Fig. 6 shows the effect of the capacitor across the nonlinear resistor in switching off the power-follow current. From Fig. 6 (c) it would be evident that the voltage across the SCR remains zero (45 volts below the virtual zero line) as long as the surge persists; see Fig. 6 (b). After the surge is over, the switching action starts and the voltage across the SCR rises up to its open-circuit voltage (the nominal zero line). The oscillogram of Fig. 6(d) was taken without the capacitor across the nonlinear resistor and, as can be seen, the voltage across the silicon-controlled rectifier did not recover.

Characteristics of the SCR as a Surge Protector. One characteristic of the SCR is that it can be made to conduct at any desired voltage level below its breakover voltage by exciting the gate with a suitable signal. Therefore, when used as an element of a surge diverter, an SCR functions essentially as an adjustable gap.

An important characteristic for a surge protector is its volt–time or time lag characteristic. By this is meant the relationship between the breakover voltage and the time to breakover. In an ideal case, the breakover voltage level should remain constant irrespective of the time to breakover. Unfortunately, however, for all practical surge protectors the breakover voltage rises for shorter times to breakover. The volt–time characteristic of the SCR was determined for two different rise times to crest (2 and 40 microseconds) of the applied wave. The results are tabulated in Table I and plotted in Fig. 7. The volt-time characteristic of an SCR is discussed in Appendix I.

SURGE PROTECTOR USING A 4-LAYER DIODE

THE STRUCTURE of a 4-layer diode[2] is similar to that of an SCR except that a 4-layer diode does not have the third electrode or gate. Therefore, to switch a 4-layer diode on, a pulse exceeding its breakover voltage should be applied to it. To switch the diode off, the flow of current should be limited below its holding-current level either by inserting a high resistance in series with it or placing a reverse voltage across it.

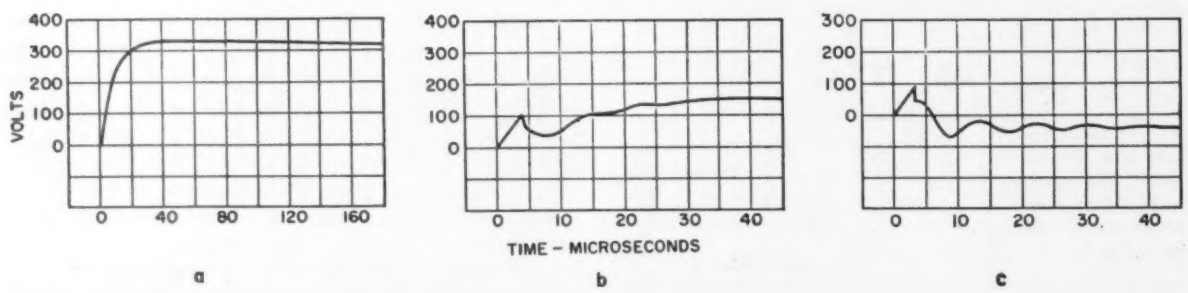

Fig. 5. Applied surge to SCR-type surge protector (with Thyrite nonlinear resistor and capacitor in parallel). Voltages measured with the negative bus as reference. (a) Without surge protector. (b) With surge protector. (c) Voltage across SCR (anode to cathode).

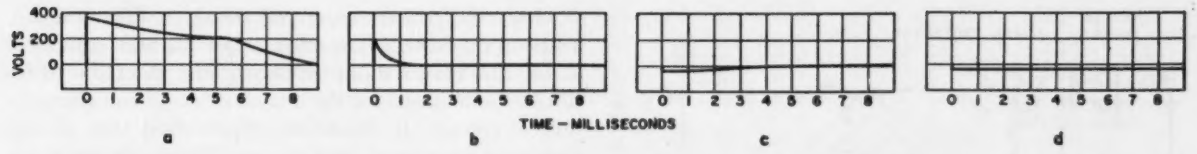

Fig. 6. Same as Fig. 5 except with longer time scale. Voltage measured with the negative bus as reference. (a) Without surge protector. (b) With surge protector. (c) Voltage across SCR. (d) Voltage across SCR but without a parallel capacitor in the circuit.

Characteristics of 4-Layer Diodes as Surge Protectors. Unlike an SCR, a 4-layer diode cannot be made to conduct at any desired voltage level. A voltage higher than the breakover voltage of the 4-layer diode has to be applied in order to make it conduct. However, although the 4-layer diode nominally has a fixed breakover voltage, this was expected to change with the rate of rise of the applied impulse wave. Therefore, its volt–time characteristic, a very important criterion for surge protection, was evaluated before it was used as an element in the surge protector. The volt–time characteristic of a 4-layer diode is tabulated in Table II and shown in Fig. 8 for applied waves having 2 and 40 microseconds time to crest. The switching voltage level of the 4-layer diode was approximately equal to its d-c breakover voltage for a considerable range of switching times; the switching voltage level decreased, however, for shorter switching times. This is fortunate, because the protective margin of this type of surge protector would not be impaired even by the fastest possible transient voltage appearing on the system. The volt–time characteristic of a 4-layer diode is discussed in Appendix II.

The 4-Layer Diode Surge Protector. The schematic diagram of the 4-layer diode surge protector is shown in Fig. 9. The 4-layer diode starts conducting on the application of a transient voltage exceeding its breakover voltage. The transient overvoltage is then absorbed by the nonlinear resistor R, and the flow of system current is arrested by the reverse voltage on the capacitor C. Fig. 10 shows the typical oscillograms of the open-circuit applied wave, the voltage across the surge protector, and the voltage across the 4-layer diode.

ANALYSIS

THE WAVESHAPE of a transient voltage in a low-voltage circuit will depend upon various parameters. If the transient is caused by lightning, then the waveshape at the terminals of the protected apparatus would depend not only on the waveshape of the lightning stroke, but also upon the attenuating characteristics of the circuit between the point of the lightning stroke and the protected apparatus. If the transient is caused by switching, its waveshape would depend upon the circuit parameters as well as the switching technique. No standard waveshape of an impulse voltage has been formulated yet for low-voltage circuits, due to lack of extensive investigation in this field. Two different front times (2 and 40 microseconds) were chosen for the determination of the volt–time characteristics, because it is anticipated that the majority of the transients would be within these limits. The tail of the applied wave, as shown in Fig. 6 (a), was arbitrarily chosen to be longer than expected in practice in order to test the proposed protectors under more severe conditions.

The difference in the volt–time or firing characteristics between that of SCR and 4-layer diode was interesting, because essentially both are 4-layer devices and therefore the SCR should have some "rate effect" similar to that of 4-layer diode. In order that the firing characteristics of SCR by surge voltages could be compared with those of the 4-layer diode, the gate of the SCR was isolated and its volt–time characteristics measured in the same way as was done for the 4-layer diode. The result is plotted in Fig. 7. It should be noticed from Fig. 7 that the general trends of the volt–time char-

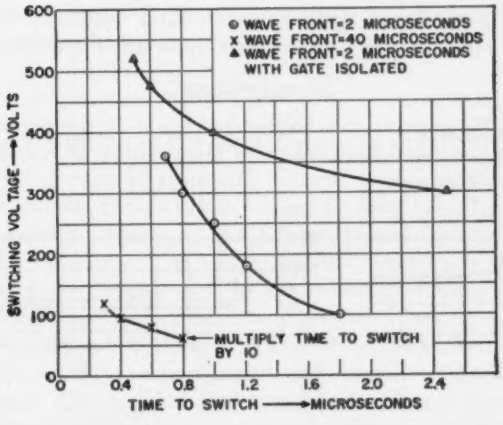

Fig. 7. Volt-time characteristic of SCR (200 volts rated PRV, GE type 358).

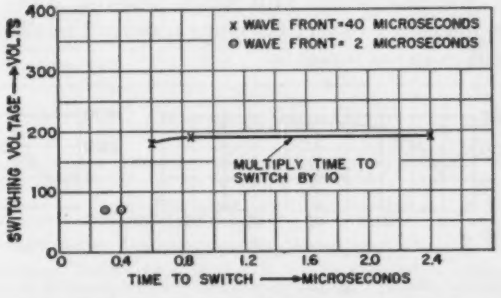

Fig. 8. Volt-time characteristic of 4-layer diode (200 volts rated d-c switching voltage, Shockley Transistor Corp. type 4G200).

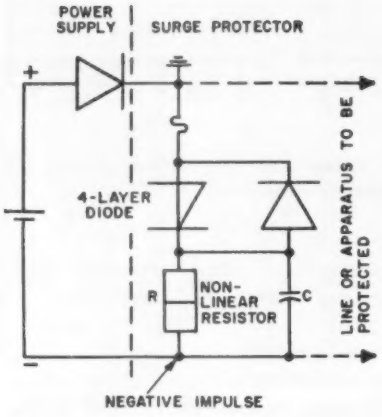

Fig. 9. Surge protector using 4-layer diode.

R, two GE *390035G1* Thyrite resistors connected in series; *C*, 5 μf; d-c supply, two 45-volt batteries in series.

acteristics of the SCR both with and without the gate excitation are similar. The effect of the gate excitation, however, is to lower the level of the switching voltage. This lowering of the switching voltage level is a very desirable characteristic of a surge protector, because then by proper design of the parameters of the gate circuit, the protective level of the surge protector can be varied at will and, therefore, tailored to any particular application. The difference in the volt–time characteristics between the SCR and 4-layer diode may be explained by the difference in the clearing time of the middle junction. It should be borne in mind, however, that only nonrecurring surges were applied and the tests at different voltage levels were made at an interval of at least a minute. Another explanation may be that the rate effect of the SCR is negligible and, therefore, the explanation as given in Appendix I in terms of delay time and rise time may be right.

The increase of the volt–time characteristic of the SCR for very short switching times may not be desirable, especially for applications where very fast rising transient voltages are anticipated. The volt–time characteristic of the SCR presently available can be made flatter by proper designing of the gate circuit. By this means delay time of firing can be improved much, but it is questionable whether rise time will be improved. Some discussions of this aspect are given in reference 4. The operation of the SCR surge protector could be made insensitive to very fast-rising transients by placing a small capacitor across it.

As was explained earlier and shown in Figs. 3 and 9, a silicon diode was connected across the SCR and later across the 4-layer diode in the reverse direction. This silicon diode protected the 4-layer devices from excessive reverse voltage. It should be remembered that all the tests were performed with a surge having the same polarity as the system voltage. This is the worst case, because once the surge is over, the system current would continue to flow if not arrested by some external means. If a surge of the opposite polarity appears across the surge protector, the 4-layer device cannot protect the apparatus without itself being damaged. But the addition of the reverse connected diode would bypass the surge safely; moreover, no system current would follow the surge because the diode is connected in the reverse direction.

The SCR used in this study was General Electric Company type *C35B*, having a rated PRV of 200 volts and rated currents of 16 amperes for continuous duty. However, currents as much as 100 amperes can be switched on and passed through a *C35B* SCR for about 16 milliseconds. The 4-layer diode used in this study was type *4G200*, manufactured by Shockley Transistor Corporation, having a rated d-c switching voltage of 200 volts and rated current of 10 amperes with surge current capacity of 100 amperes. In low-voltage circuits surge currents exceeding 100 amperes are hardly to be expected. Other ratings may have higher or lower ratios of allowable switch-on and short-time current to steady-state current and, therefore, they may be applied according to the need of a particular circuit.

In Figs. 2, 3, and 9, the diode in series with the d-c power source was primarily used to offer a high impedance to the applied surge and thus to facilitate in providing a surge of the desired magnitude and waveshape. However, this combination of the d-c battery and the diode would also represent a rectified d-c source. On no account should the oncoming surge exceed the peak reverse voltage of the rectifiers; therefore, a surge protector is needed. However, if the oncoming surge is of opposite polarity, the rectified power source offers almost a short circuit to the surge and, therefore, the surge cannot build up; or in other words, the rectified power source is self-protecting in one direction.

CONCLUSIONS

1. Surge protection for low-voltage d-c circuits can be achieved by surge protectors using either SCR's or 4-layer diodes.

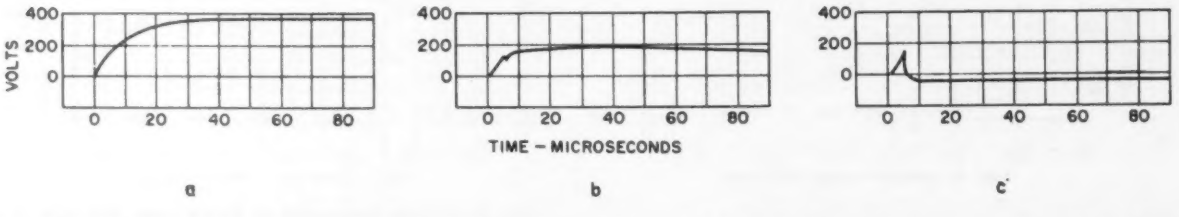

Fig. 10. Surge voltage on 4-layer diode protector with nonlinear resistor and capacitor in parallel. Voltages measured with negative bus as reference. (a) Applied voltage without protector. (b) Applied voltage with protector. (c) Voltage across 4-layer diode (anode to cathode).

2. The SCR-type surge protectors have the added advantage that their protective levels can be varied at will by changing the parameters of the gate circuit.

Appendix I

VOLT-TIME CHARACTERISTIC OF SILICON CONTROLLED RECTIFIERS

The volt–time characteristic of the SCR was determined by increasing the open-circuit applied wave from the 100-volt level in steps of 100 volts. From the oscillogram, the switching voltage and the corresponding time to switch was evaluated. The volt–time characteristic of the SCR was determined for two different rise times to crest (2 and 40 microseconds) of the applied wave. The results are tabulated in Table I and are plotted in Fig. 7. These characteristics are for General Electric type *C35B* SCR's. Other units of the same and other manufacturers may have substantially different values, although the general pattern would be typical of all.

For a given gate pulse, there is a time lag, known as delay time t_d, for the SCR to start conducting. With higher gate pulse, t_d decreases and approaches the minimum of 0.2 to 0.5 microsecond. After the SCR has started to conduct, it requires some more time lag to be in the fully conducting state. This time lag, known as rise time t_r, can vary from 0.5 to 3 microseconds depending on the circuit. The rise time t_r decreases as the voltage is increased or as the load current is decreased. If it is assumed that the gate firing level is independent of the waveshape of the gate pulse and that t_d and t_r are constants, then the time lag characteristics of the SCR can be interpreted as shown in Fig. 11. Because of the different rates of rise of the applied waves, the SCR starts conducting at different times t_1, t_2, t_3, and t_4. After a fixed interval $t_T = t_d + t_r$, the SCR fully conducts and the applied voltage across it collapses. However, the time intervals between the application of the applied wave and the voltage collapse across the SCR are $(t_1 + t_T)$, $(t_2 + t_T)$, $(t_3 + t_T)$, and $(t_4 + t_T)$ for the different voltages; hence the voltage levels at which the SCR fully conducts are V_1, V_2, V_3, and V_4. This shows qualitatively the shape of the time lag characteristics of the SCR.

Appendix II

VOLT-TIME CHARACTERISTIC OF A 4-LAYER DIODE

The change of switching voltage of 4-layer diodes with rate of voltage rise is known as "rate effect." The two outer p-n junctions of a 4-layer diode behave as two forward-biased silicon diodes, and the middle n-p junction can be represented by a parallel combination of resistance and capacitance. In the nonconducting state, the total applied voltage would be across the middle n-p junction. Two components of current would flow through this n-p junction: (a) a resistive component I_R flowing through the equivalent resistance and determined by the magnitude of the applied voltage, and (b) a capacitive component I_C, given by $C\ (dV/dt)$,

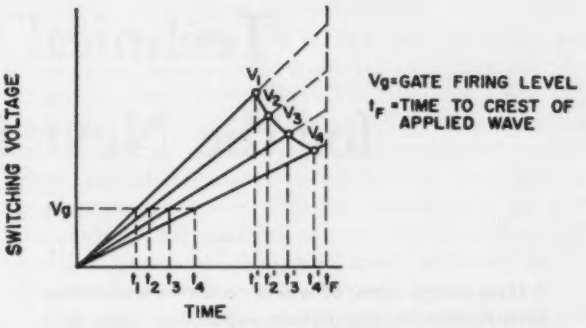

Fig. 11. Switching characteristic of SCR with an impulse wave.

where C is the equivalent capacitance of the n-p layer and dV/dt is the rate of rise of the applied voltage. Therefore, the total current $(I_R + I_C)$ at the n-p junction would be higher when the voltage is applied at a definite rate than at pure d-c, and this total current would increase with the rate of voltage change. As the avalanche voltage is dependent on the current flowing through this junction, the breakover voltage of the 4-layer diode would be lower the higher the rate of change of voltage. A comprehensive explanation of this rate effect is given in reference 5. It should be pointed out in passing that the volt–time characteristics of Fig. 8 were taken without any direct voltage superimposed on the 4-layer diode. In the normal operating condition a direct voltage will be superimposed on the 4-layer surge protector. Although the superimposed direct voltage will increase the breakover voltage of the 4-layer diode,[5] it will not exceed the d-c breakover value.

Table I. Switching Characteristic of an SCR by an Impulse Voltage

	Wavefront, 2 Microseconds					Wavefront, 40 Microseconds			
Switching Voltage	100	180	250	300	360	60	80	95	120
Time to Switch, microseconds	1.8	1.2	1.0	0.8	0.7	8	6	4	3
Applied Surge, volts	100	200	300	400	500	100	200	300	400

Table II. Switching Characteristic of a 4-Layer Diode by an Impulse Voltage

	Wavefront, 2 Microseconds				Wavefront, 40 Microseconds		
Switching Voltage	60	60	60	60	190	190	180
Time to Switch, microseconds	0.4	0.3	0.3	0.3	24	8.5	6.0
Applied Surge, volts	200	300	400	600	200	300	360

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Technical Manpower for the Next Hundred Years

J. R. WEIR

A long-range view of world needs—considering such factors as population expansion, food and energy requirements, natural resources, and the rise in standard of living—indicates that the technical manpower shortage is here to stay.

THE ECONOMICS of technical brainpower in a modern industrial civilization continues to grow in importance. In fact, it seems quite possible that the number and quality of trained technologists available to the nations of the world will determine the rate at which standards of living can be raised, the rate at which underdeveloped nations can industrialize, and the rate at which we can build the educational facilities so necessary for survival in an atomic age.

In considering this problem, I should like to describe some of the more important trends that have contributed to our present short supply of scientists and engineers and then see what conclusions we might arrive at by projecting them into the next century. I will leave to Mr. Ingram, in the article which follows, the more difficult task of making specific recommendations on how the current technical manpower shortage might be alleviated.

For at least half a billion years, man's working skills and knowledge were very limited. For all but the last two centuries of recorded history, only a small minority of the working force in any society was made up of skilled craftsmen. The majority were farmers, tradesmen, and unskilled laborers, and almost any lifetime occupation required little ability and could be learned without formal education. But this began to change during the 18th Century with the Industrial Revolution and the beginning of the Scientific Era. Now the skilled mechanic, the inventor, the engineer and the scientist came into being. As increased knowledge of the physical world permitted increased industrialization, the need for highly trained workers and for professional scientists and engineers also increased. At the same time, the demand for farmers and unskilled laborers progressively declined.

For example, in the United States in 1900 there were 11 million farmers; in 1950, there were only 7.5 million. Yet in 1900 they represented 38% of a working force of 28 million, while in 1950 they represented only 13% of a labor force doubled to 60 million.

Even greater changes occurred among the professions. In 1900, 1 million professional and technical workers made up 4½% of the labor force. By 1950 this group had increased fourfold, and now it constituted 7½% of the working force.

A current report of the Department of Labor notes that for the first time in the history of the United States the number of persons employed as professional, office, and sales workers exceeds the number employed in manual occupations. The Department predicts a growth rate for professional and technical workers that is nearly double that of any other occupational group. They expect no change among unskilled workers and a decline among farm workers.

These figures suggest that the current shortage of engineers and scientists is but one aspect of a larger and more general problem: the absolute necessity for a large variety of highly skilled manpower in order to develop and operate a complex industrial civilization. These long-term changes in the composition of the labor force as our nation went from an agricultural to an industrial economy provide a basis for forecasting world-wide manpower needs for the future. Many of the factors that produced them are obscure and exceedingly complex, but a consideration of just a few of the more obvious ones will, I think, lead us inevitably to the conclusion that the demand for scientific and engineering know-how, for technical brainpower, will continue to increase for many years to come.

Let us look first at what is perhaps the most powerful element in the whole system: the pressure of increasing world population.

This is a matter that is receiving extensive publicity and certainly needs no detailed documentation here. A few general figures will indicate the nature of the problem and the magnitude it is likely to assume.

It has been estimated that the population of the earth in the year 1000 was about 300 million. It had taken something like a million years to reach this figure. Only by about 1830 did the human race reach 1 billion in number. By 1930, 100 years later, the second billion was added. It will take 35 years to add the third billion; we will reach it in 1965. The United Nations estimates it will take 15 years to add the fourth and 10 to add the fifth. By the turn of the century we should be 6 billion strong, or perhaps I should say 6 billion thick!

Clearly world population is not only increasing rapidly, but of even greater significance, the rate of increase

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is growing rapidly as well. Between 1850 and 1900, world populations grew by about 0.7% per year, a rate that doubled the population every century. Between 1900 and 1950, the average annual rate of increase was 0.9%, shortening the doubling time to about 75 years. The projections for the period 1940 to 1980 predict a rate of increase of 1.3%, or a doubling time of only 50 years. Will there be 6 or 7 billion people by the end of this century, and perhaps 12 to 14 billion by 2050?

These figures indicate a doubling of world population within the lifetime of many of us here today. But they also suggest an increase in the need for technological services far beyond a mere doubling of present demand.

FOOD PRODUCTION

The second factor to be considered is food production. It seems probable that a large proportion of the human race has never had enough to eat. Starvation and famine have existed throughout recorded history and continue to exist in many areas of the world today.

In the period from 1900 to the beginning of World War II, total world food production increased 10 to 15%. But in the same period of time world population increased 30%. The war decreased food supplies over most of the earth's surface and the prewar level was not regained until 1952; but by this time there were, of course, even more people to feed.

So there are more hungry people in the world today than ever before and they seem to be getting hungrier. Austin White's figures indicate the average daily food intake for French and English prisoners of war and convicts in America in colonial times was 2,735 calories per day. The United Nations estimates 55% of today's world population gets less than 2,250 calories per day, and an additional 25% between 2,250 and 2,750 calories per day. Three quarters of the people of the modern world get less food than the prisoners and convicts of two centuries ago.

There are increasingly insistent demands from these hungry people that they receive more food, and recent political and economic revolutions give strong support to the view that these demands will be met, hopefully in a peaceful manner.

James Bonner has calculated that a full application of modern agricultural technology, if applied to all the cultivable areas of the world, could produce sufficient food to provide an adequate diet for the 6 or 7 billion people that will populate the earth by the turn of the century. However, such application would require the spreading of the science and technology of farming to all parts of the world. It would require facilities for worldwide agricultural education, factories for the manufacture of fertilizers, tractors, insecticides, etc., and the irrigation of most of the arid regions of the earth. It would also require a continuing program of basic and applied research on agricultural problems. The necessary technology is now available; only its application by trained technicians remains to be accomplished, a task requiring thousands of engineers and scientists.

MATERIAL RESOURCES

Up to the last century or two, raw materials, our third factor, have assumed a relatively unimportant part in man's struggle for survival. He fashioned a few artifacts from relatively pure metals which he found lying on the surface of the earth; his extremely limited knowledge of metallurgy prevented him from exploiting less pure deposits. This was equally true for outcroppings of all minerals and for surface deposits of coal and petroleum. He could make only very primitive use of them.

This situation changed with the invention of the Scientific Method and the advent of the Industrial Revolution. The discovery of the scientific principles governing the physical world enabled man to release the energy in coal and oil and harness it to machines for productive work. As industrial processes were developed the demand for raw materials increased rapidly and forced the development of techniques for obtaining raw materials from less pure sources.

For example, primitive man could pick up almost pure copper lying on the surface of the earth. However, as the demand for copper increased with growing industrialization, it became necessary to go to lower grade ore. By the beginning of this century we were processing copper ore with an average concentration of 5% copper. Today this has dropped to 0.8% and we can certainly look forward to its dropping even lower, perhaps to 0.1 or even 0.01%.

Technologically, there is essentially no lower limit to the grade of an ore which can be processed. Ordinary igneous rocks contain most of the elements necessary for the perpetuation of a highly industrialized society, and in proportions which are not unreasonable from the point of view of industrial needs. For example, 100 tons of average igneous rock contains about 8 tons of aluminum, 5 tons of iron, 180 pounds of manganese, 40 pounds of nickel, 20 pounds of copper, and 4 pounds of lead. Many of the elements which are not found in sufficient quantity in igneous rocks, such as chlorine, bromine, and iodine, can be found in the oceans. Other elements, such as nitrogen and oxygen, are readily available in the atmosphere. Still others can be found in the practically inexhaustible supplies of limestone (a source of carbon), gypsum (a source of sulfur), and phosphate rock (a source of phosphorus). Given the necessary energy and enough technologists to develop the processes of extraction, the people of the world could, if need be, support themselves entirely with the leanest of ores, the waters of the oceans, the rocks of the earth's crust, and the air around them.

The fourth factor is the level of industrialization and the accompanying standard of living.

Before the Industrial Revolution, the manufacture of consumer goods was insignificant and limited to products that could be made by hand. Many man-hours and relatively few raw materials were consumed in the production of the barest essentials needed for a meager existence. The machines of the Industrial Revolution altered this in a most profound way. The individual

machine operator could produce many times more than the hand craftsman and with much less effort. This meant greater quantities, greater variety, and lower prices, but it also meant increased consumption of energy and raw materials. An industrialized nation, as compared with an unindustrialized one, consumes energy and raw materials in prodigious quantities.

For example, per capita annual steel production in India is about 9 pounds per person; in the United States, it is 1,300 pounds. India consumes 1/10 barrel of oil per person per year; the U.S., 170 times as much.

Obviously it takes great technological know-how to design and build the equipment necessary to consume such quantities of raw materials as we do in the United States. When U. S. levels of consumption are considered in conjunction with the demand of underdeveloped countries that they be helped to industrialize, the magnitude of the problem becomes distressingly clear.

For example, if the present proportion of world population now living at extremely low levels of consumption—approximately 2 billion persons—were to be brought up to the standard of living of contemporary United States, we would have to extract from the earth 18 billion tons of iron, 300 million tons of copper, 300 million tons of lead, 200 million tons of zinc, 30 million tons of tin, in addition to huge quantities of other metals and nonmetals. These are totals well over 100 times the present world annual rate of production. These quantities of copper, lead, zinc, and tin are considerably greater than could be removed from all measured, indicated, and inferred world reserves of ores of these metals.

From these figures I think we might infer that the need for technical brainpower necessary to meet just the minimum expected demands for higher standards of living in underdeveloped countries will certainly overtax present world manpower resources.

ENERGY

IT TAKES ENERGY to extract metals from low-grade ores; it takes energy to manufacture equipment and to run it; it takes energy to produce food. Current world energy consumption from the three major sources—coal, petroleum, and natural gas—is equivalent to about 3.7 billion tons of coal per year. If all the people of the world were to expend energy at the per capita rate at which we do in the United States, consumption would increase sixfold to the equivalent of approximately 22 billion tons of coal each year. This is a rate of consumption that would exhaust the fossil fuel reserves of the world in 40 or 50 years. But it is also a rate dictated by the U. S. standard of living, a standard of living envied and sought by the rest of the world with increasing aggressiveness.

Certainly, if these demands are to be met we must develop other sources of energy, and it seems possible to do so from nuclear fission. Harrison Brown has calculated that in every ton of ordinary granite, energy which is equivalent to about 15 tons of coal can be economically extracted in the form of localized uranium and thorium. This means that from the long-range point of view man will be able, if it becomes necessary, to extract his energy needs from the very rocks of the earth's crust, the same rocks that can supply the variety of metals needed for the support of a highly industrialized world civilization.

Once again the ultimate problem is the development and application of the scientific and engineering know-how, the know-how necessary to develop the processes for the consumption of such vast quantities of energy.

The sixth and final factor is that of the ever-increasing complexity of modern industrial civilization. This contributor to the rising demand for technical brainpower, while not as easily documented as the preceding five, seems to be as important and as inevitable as the others. As populations increase, we see it in the emergence of more complex social, political, and economic systems. As the standard of living rises, we see it in more complex production, transportation, and consumption facilities. We see it in the increased specialization of occupations. We see it in the rapidly increasing complexity of scientific technology. This ever-increasing complexity—of knowledge, of human needs, and of human organization—is traceable throughout the recorded history of man and appears to be an inevitable consequence of a scientific–industrial civilization. Unfortunately it also consumes the attention and energies of highly trained manpower, both technical and nontechnical. Consequently, one is again forced to the conclusion that this source of demand for scientists and engineers can only increase in the future, also exponentially.

In very general terms, then, the situation seems clear, and extremely challenging. Exploding populations of hungry and deprived people are demanding equal access to the resources of the earth. They affirm their right to a standard of health and comfort comparable with the third of the world's population that makes up its privileged peoples, and we have seen that the achievement of this goal is technologically possible.

They can be denied their rights and held in subjugation, for a while at least, or they can be helped to achieve their objectives wherever possible. The Free World, and especially the United States, has chosen the latter alternative and is already committed to a program of technical assistance. It seems to me there is no alternative in the long run. However, this means spending increasing amounts of energy to produce greater quantities of goods from lower and lower grade raw materials for more and more people, and building the complex facilities and organizations necessary for an industrial civilization that will encompass the entire earth.

This is a situation that is unique in the history of mankind. It is the consequence of the evolution of technical–industrial society. It has no parallel in the past and leads one to an inescapable conclusion for the future: The demand for technical know-how must inevitably increase for many decades and perhaps centuries to come, probably at a geometric rate. Whether we like it or not, the technical manpower "shortage" will be with us from here on.

Scientific and Engineering Manpower

The Immediate Problem and Suggested Solutions

S. B. INGRAM
FELLOW AIEE

Our needs for technically trained people may shortly be expected to outrun permanently our ability to satisfy them. Possible remedial measures by government, industry, educational institutions, and the engineering profession are suggested.

THE immediately preceding article by Professor Weir convincingly demonstrates the fundamental nature and the startling magnitude of the world's long-range requirements for technical manpower. I should like to approach the problem of the shortage of scientific and engineering manpower in its more immediate aspects here in the United States, and to make some suggestions for a program of action to cope with it.

What I should like to do is to lay before you some facts which seem to me to be significant. I believe that if there were a wider public awareness of these facts and their implications, the groundwork would be laid for constructive action.

THE FACTS ON MANPOWER

THE FIRST FACT stated by Professor Weir is that we, as a nation, are facing a chronic and continuing shortage of scientific and engineering manpower. He has amply demonstrated that our future demand for this manpower is stupendous. I should like to argue that our supply of technological manpower has a very definite limit and that we are not far from reaching this limit at the present time. To save time, I shall illustrate the point specifically by some figures with respect to our capacity to produce people trained in engineering, since the same line of reasoning can be applied with equal force to those trained in science.

At the present time only about 9% of our college entrants or 15% of our male college entrants have the interest, the aptitude, and the necessary preparation to embark on engineering courses and only about half of these graduate. Engineering educators estimate that only those young people scoring above 120 on the Army General Classification Test are capable of successfully completing engineering training. This is about 17% of the group. Now this does not mean, by any stretch of the imagination, that all of these 17% may be regarded as potential engineers. Far from it. In the first place, half of these are women, and while experience has shown that we can get a small number of scientists and a smaller number of engineers from this group, barring a sociological revolution we cannot count on them to contribute in substantial numbers to our reservoir of potential engineers. This brings us from 17% down to 8½%. Now we have to consider that this remainder has to supply not only the engineers we have in our society, but also members of the other professions and occupations which make the same high demands on intellectual capacity that engineering does. In the past, engineering has succeeded in getting about one fourth of these. Whether this figure can go much higher is questionable. We certainly cannot put all our highly intelligent people in engineering, and very many of them would not be successful at it even if they tried. It takes a lot of other qualifications in addition to intelligence to be an engineer. It takes a mathematical mind. It takes an interest in physical things and physical phenomena. Engineering does not give an adequate outlet for some of the other basic aptitudes and interests which intelligent people have. Many a successful lawyer, journalist, or social scientist would be wasted as an engineer, and besides, our society needs these people in those fields into which their aptitudes and interests properly channel them. So if we assume that we will not be able to increase this fraction of one fourth by a substantial degree, we conclude that our potential capacity for the production of engineering graduates is about one fourth of the 8½% or about 2% of the 2,600,000 young people coming of college age each year. This number is 52,000—not far above the 38,000 engineers we graduated in 1959. Even this 2% figure does not represent ultimate additions to our national engineering force, because it takes no account of losses of trained engineers to other occupations. A study was made in 1953[1] on a large sample of college graduates of the classes of 1930, 1940, and 1951. Of this group of engineering graduates, only 64% were doing professional engineering work as of 1953. We thus lose about one third of those we graduate as engineers from our engineering schools and, in return, we gain comparatively few to the profession from other sources. A more realistic figure then for our capacity to add to the engineering segment of our labor force is 1⅓%, and

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this, I believe, is one we can hope to exceed only with considerable difficulty.

My next point, also made by Professor Weir, is that our need for technically trained people has increased continuously in the past and may be expected to do so in the foreseeable future. A National Science Foundation study on our scientific personnel resources[2] traces the growth in the percentage of our population engaged in professional work in science and technology over an 80-year period from 1870 to 1950. This percentage was, in 1870, 1910, and 1950, 0.03%, 0.2%, and 0.7%, respectively. The basis for this steady increase, of course, has been the continuous growth in the complex technological nature of our civilization over this 80-year period. Certainly, we can say that this growth has continued over the decade since 1950. I know of nobody, certainly no responsible spokesman for science, who is willing to predict any cessation in this trend. Professor Weir has given what in my opinion is the ultimate justification for extrapolating this demand curve upward.

My final point, which is a corollary of the two preceding, is that our needs for technically trained people, which we have always been able to satisfy in the past, may shortly be expected to outrun permanently our ability to satisfy them. Our shortage of scientists and engineers, as Professor Weir has said, has indeed become chronic.

This does not say that in times of business recession, as in 1958, there may not appear to be temporary easing of the shortage, but this is a transient market condition associated with the business cycle and we should not be misled by it. When business turns upward again, the engineer and scientist shortage will be back with us once more and in a more acute form than ever.

THE INTELLIGENCE BARRIER

THE SECOND FACT is that this situation in which we find ourselves is absolutely unique in the history of Western civilization or of any civilization for that matter. We are up against a fundamental limitation that we might call "the intelligence barrier," in which we are approaching maximum utilization of our potential intellectual resources. It is not easy; it probably is not even possible to break through it. Always before we have had large untapped resources of potential technical manpower. If we needed more, all we had to do was to provide our intellectually able youth with educational opportunities and suitable incentives and we could increase our output of scientifically trained people to fill our needs. At this point, our production is about up to capacity. It will not be easy to make any major increase in it. We can try to attract a greater proportion of our youth to technical careers. In so doing, we will have to attract them away from other fields—medicine, law, journalism, business. We can try to attract more women into the profession. This runs counter to the present trend toward early marriages and large families and requires something of a sociological revolution, which is not easy either. We can import more trained scientists and engineers from abroad. They have some very good ones there, but they need them too. In the underdeveloped countries there is plenty of potential technical talent in an undeveloped state, but again, there are sociological and political problems in developing it for utilization in this country. So the tempting argument that "we've always muddled through before; we'll do it again this time" is not a valid one. The present situation is not an old one in slightly different form; it is brand new in kind. We have no historical experience to fall back on.

The third fact is that in the face of our great need for technically trained personnel, our young people are not flocking to careers in science and engineering. Freshmen engineering enrollment has actually declined in each of the last 2 years and this in the face of the great flurry of publicity about science following Sputnik. The figures are: engineering freshmen down 7% in 1958 and 3½% in 1959 from the preceding year. While engineering enrollment has been going down, over-all freshman enrollment has been going up: 7% in 1958 and 5.9% in 1959. The percentage of all college freshmen embarking on courses in engineering has declined from 10.8 in 1957 to 8.2 in 1959 and this in the first two years of the Space Age. Some of this decline may be accounted for by a shift from engineering to science although this is hard to pin down because we do not have as good statistics for science majors in college as we have for engineers; but in any case, the increases in science are insufficient to offset the declines in engineering.

The fourth fact is that our principal competitor on the world scene, the Soviet Union, has a more realistic approach to its scientific and engineering manpower problem than we have. Science and engineering place much higher on their scale of values than they do with us. Scientific and engineering careers carry more prestige and more money relative to other occupations than they do here. I will not try to go into a comparison of Soviet and American science other than to cite a few significant statistics. The Russians are graduating 100,000 engineers a year compared with our 38,000. The quality is good, as is borne out by Russian technological achievements. They are graduating many more technicians than we are—one quarter of a million compared with our 15,000. The Russians are making extensive use of women in science—36% compared with our 2%. A much larger percentage of Soviet university students is in science or engineering than is the case with us—about 50% in the Soviet Union, as compared with our 25%. Mathematics and science comprise a much larger percentage of the secondary school curriculum than is the case in our high schools—35% with them, about 20% with us. We would be foolish to be complacent in the face of such comparisons.

The fifth fact is that engineering and science, particularly engineering, have a problem in communication with the public. In this technological age the public needs to know enough about science, about scientists and engineers, and about what the work of the scientist and engineer is so that the feeling of remoteness which

most people now have for these things is dispelled. This is particularly true of the youthful public from which our future scientists and engineers must come and of the parents and teachers who guide them. The public needs to know the difference between science and engineering. Science is understanding nature. Engineering is the application of natural law for the benefit of man. The launching of an earth satellite is an engineering achievement. The use of an instrument in the satellite to obtain knowledge of the radiation belt surrounding the earth in space is a scientific experiment. This semantic confusion would not be serious except that the public tends to endow science with more than its share of glamour. As a result, many of our college freshmen are inclined to set their sights on a scientific career when they would be better advised to seek a career in engineering.

These are the facts. What can we do about them?

A PROGRAM FOR SCIENTIFIC AND ENGINEERING MANPOWER

IF WE ARE FACED, as I hope Professor Weir and I have convinced you, with a chronic shortage of scientists and engineers which will become continuously more acute as time goes on, what is the program of action which is called for? I am not presumptuous enough even to try to suggest a solution for the gigantic technological manpower problems of the next century which Professor Weir poses. I shall concern myself with the immediate future, perhaps the next decade. I believe we should attempt to solve the problem by the simultaneous application of three different methods of attack, and in each case we should bring to bear the co-ordinated efforts of government, industry, our educational institutions, and of the scientific and engineering professions. Broadly speaking, the three methods of attack are these.

First, since we are dealing with a shortage, we should take steps to increase the supply by trying to increase the number of scientists and engineers graduating from our educational institutions. This is the quantity method.

Second, we should strive to increase our technical productivity by making the most efficient use possible of the scientists and engineers we do have. This is the utilization method.

Third, since this technical productivity is not a matter of numbers alone, but also of the quality of the individuals, we should try to improve and maintain the quality of our scientists and engineers at the highest level. This is the quality method.

All of these things we will assume should be done within the framework of our democratic system of freedom of choice for the individual. Let us look at them in more detail and ask, "What needs to be done and by whom?"

WHAT SHOULD GOVERNMENT DO?

SINCE this is a national problem, perhaps even a problem of national survival, it is natural to ask first, what should the government do?

Since our program of action should be based on a thorough study of the facts, we of the Engineering Manpower Commission believe that a new National Manpower Resources study should be undertaken at the White House level. We believe that such a study would confirm the conclusion that Professor Weir and I have reached with regard to the chronic nature of our engineering and scientific manpower shortage. We hope that it would lead to a program of action not unlike the one I am about to outline.

We believe that the question of manpower planning in the Federal Government is of vital enough importance to be given a higher place in the Executive Branch of the Federal Government than it occupies at the present time. Within the last few years the top responsibility for this function has been downgraded one level in the Office of Civil and Defense Mobilization. It ought to be promoted and not demoted.

With regard to the quantity attack on the manpower problem, government is acting in two areas at the present time. It is providing financial aid to those who have the ability but not the financial resources to pursue programs of higher education. This is being done by the Federal Government through the student loan provisions of the National Defense Education Act. State governments also have student aid programs of various sorts and, of course, the maintenance of state schools with moderate tuition charges is a major contribution in this area. Programs specifically directed at the fields of science and engineering rather than at higher education in general, and those directed to the aid of the top students rather than of all of those capable of achieving the goal of college admission, would be realistic, if unpopular, ways of attacking the problem at hand.

Evidence is clear that a greater need than that for student aid is for financial support of the educational institutions themselves. This must be on a generous scale to enable them to attract and maintain qualified faculties in competition with private industry. Adequate faculty salary scales are a must. Since we are dealing here with government's role, we are concerned with the financing of governmentally supported institutions, principally state universities.

With regard to the utilization attack, government needs to do several things. In the first place, it should see that its own house is in order with regard to its efficient use of scientific and engineering personnel on the government payroll. Its problem is most difficult in the case of technical personnel in uniform in the armed services because a strictly rational utilization program runs counter to some traditional military practices. The military services have been wrestling with this problem in recent years and have made commendable progress. They should go much further. A career technical service for scientists and engineers in the regular armed services similar to that which we already have for doctors and dentists is a concept which, if implemented, could con-

tribute substantially to our national military strength and at the same time economize on our precious technical manpower.

The drafting of young scientists and engineers into the armed services, except in the case of an overriding military necessity for their services, and for assignment to technical work which uses their technical capabilities to the fullest is a practice which can only be regarded as anachronistic. As a matter of fact, it is currently taking place very infrequently, but this is true only because the available pool of draftable youths exceeds the current numerical requirements of the armed services. The draft boards, under enlightened directives from the Selective Service System backed by the Department of Defense, have been liberal with occupational and educational deferments for technical personnel. Actually what is happening is that we are maneuvering our way around the provisions of a Selective Service Act which is completely outdated in the fundamental premise on which it is based, that is, service on the basis of equality of sacrifice rather than service on the basis of greatest contribution to the defensive power of the nation. What is needed is a new Selective Service law under which engineers and scientists may discharge their obligation through either civilian or military service as the public interest and the national welfare may require. Assignment to either type of service should be by local Selective Service Boards acting under directives from the Selective Service System. When invited to testify before the Senate Armed Services Committee in June 1959 when the Selective Service Act of 1955 expired and new legislation was under consideration, the Engineering and Scientific Manpower Commissions advocated such a law. The suggestion was sympathetically received by the Committee and is favorably regarded by many of those concerned with manpower problems in Washington, but so far it has not been politically possible to make any effective headway in Congress. We continue to live dangerously with a simple extension of the 1955 law. Under the present conditions, this does not matter much, but in case of a brush-fire war or other circumstances requiring partial mobilization which would re-establish pressure on the draft pool, we would find ourselves disrupting vital technical programs through selective service calls on engineering and scientific personnel.

WHAT SHOULD INDUSTRY DO?

WHAT IS industry's responsibility for increasing the size of our technological labor force? Since industry is the principal employer of scientists and engineers, it too can well afford to support the educational institutions from which it recruits them. Industry is already doing this on a considerable scale, but it will be called upon to do more. Since government institutions can look to the taxpayers, including industrial taxpayers, for support and since the philanthropic sources which have provided a major source of income for private institutions are gradually drying up, industry's contributions should probably concentrate in this area. Our private institutions play a vital role in our American system of higher education and the fraction of the total college population which is enrolled in them is steadily declining.

One of the incentives which will attract more young people into scientific and engineering careers is the financial incentive. Industry should be prepared to give adequate compensation to technical employees so that careers in these fields are attractive in comparison with others. The law of supply and demand will probably provide the needed stimulus in this case without any specific program. Scientists and engineers have been enjoying a seller's market for their services for the last decade and will doubtless continue to do so. The Engineers Joint Council survey of engineering salaries records a steady increase in starting salaries of engineering graduates which averages 6½% a year since 1953. A marked differential has developed between the starting salaries for engineers and those for liberal arts or business administration graduates.

In the field of utilization, industry should carefully and continuously review its management practices to see that its technical personnel of professional grade is being used for work on professional level only. It should support its scientists and engineers with adequate assistance in the form of help from scientific and engineering technicians.

Industry too has a major contribution to make in our third method of attack, that of maintaining the quality of our technological labor force. We are accustomed to the concept of the obsolescence of physical equipment. We less often think in terms of the obsolescence of people and their capabilities, but it is a very real problem in the rapidly advancing technology of today. It will be a problem of greater moment as our technological labor force, whose age distribution is now heavily peaked at the younger years, ages. In the matter of keeping himself up to date, a scientist or engineer has to run pretty fast just to stay in the same place. The ultimate responsibility of doing so rests on his own shoulders. Nobody can do it for him, but industry can help its employees and should. The maintenance of employees' professional capabilities is as necessary and justifiable a business expense as is the maintenance of plant and equipment. Tuition refund plans, in-plant training in new fields of technology, and the sponsoring of postbaccalaureate study programs for mature engineers at educational institutions are some of the methods industry can use to help in achieving the goal in this area.

WHAT SHOULD EDUCATIONAL INSTITUTIONS DO?

THE ROLE of education is obviously a key one in the solution of the manpower problem with which we are concerned. If more and better scientists and engineers are to be produced, it is on our institutions of higher learning that the principal burden of producing them must fall. However, the problem actually begins at the secondary school level. Improved preparation for college study in science and engineering is badly

needed. This means that mathematics and science should be stressed in the high school curriculum and given as required courses rather than offered as electives. The high school graduate deciding on a science or engineering goal when he enters college should not find himself handicapped by his high school background.

In the guidance field, much needs to be done. There are a number of factors which may influence able students to select career goals in science and engineering. The attitudes of parents, of high school guidance counselors, and of teachers probably have the greatest effect. These three groups all need to gain a better appreciation of the opportunities awaiting young people in the fields of science and engineering. They also need to learn to distinguish between science and engineering. They need as well to learn to guide many more students toward college-level work in 2-year technical institutes to prepare for careers as engineering technicians. Our task is that of educating not only students, but also those who influence them. This is a part of the problem of communication with the public referred to earlier.

Our institutions need to grow much faster in some directions than in others. One urgent need is for more graduate facilities, particularly in engineering. The need for engineers trained to the graduate level is acute and the pressure of this need has caused many industries to make up the deficiency by developing their own supply. This is done by subsidizing employees with payment of tuition and granting of time off the job for graduate study. Where major industrial locations lack neighboring graduate facilities, the universities are under pressure to establish off-campus programs to fill the void.

A more adequate supply of engineering technicians is badly needed. The guidance problem in this field has just been discussed. At the moment, facilities are not overcrowded. Only when guidance efforts produce such results as they deserve can we say that educational institutions should expand in this area. The ultimate necessity, however, cannot be questioned.

A need which is rapidly growing is for updating programs for mature engineers employed in industry. This was discussed earlier under "industry's responsibilities" but it is an important problem which can be adequately solved only by the joint efforts of industry and of our educational institutions.

WHAT SHOULD THE ENGINEERING PROFESSION DO?

FINALLY, since we are members of the engineering profession, we should, of course, ask ourselves, "What is it our responsibility to do as members of that profession to contribute to the solution of the engineering manpower problem?" The engineering societies with their nationwide organizational structure are in a position to make important contributions, particularly in the fields of career guidance and of the public relations of the profession.

The national societies and their joint organizations, the Engineers Joint Council (EJC) and the Engineers Council for Professional Development (ECPD) are active in these fields. EJC has set up the Engineering Manpower Commission to co-ordinate its manpower interests and to serve as a communications channel for the profession with government, industry and the public. ECPD through its Guidance Committee makes career literature available for the use of high school students, teachers, and guidance counselors. These are important activities and should be adequately supported, both financially and through the voluntary efforts of the society members.

It is at the local sectional level that the greatest opportunities for establishing or expanding effective programs exist. Local engineers should co-operate with educators in their own communities by giving assistance to them in the guidance of students regarding engineering careers. Participation in "career days" and the arrangements of plant visits for high school students are examples of what can be done in this field.

In the area of public relations, we of the profession need to take action at all levels. EJC is in a good position to represent the profession to government, and to the public at large. We should not, however, stop with our support of EJC. In public relations, as in guidance, the local section has an important role to play. The local citizen, high school teacher, or student is probably more influenced in the image which he forms of the engineering profession by contacts or observations which are part of his own personal experience than by any advertisements, press releases, or publications it is possible to originate at the national level. To find ways appropriate to the local situation to influence this image in a constructive way is a challenging problem. It should form a major objective in developing the program of each local section.

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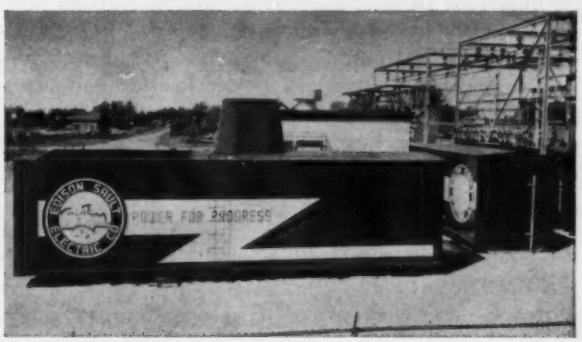

Edison Sault Electric Company's new diesel peaking plant is now in operation at Manistique, Mich. The 2,000-kw automatic unit "peaks" 5 days a week for up to 4 hours a day. It was put into commercial service in August 1960. The peaking plant was designed and built by Electro-Motive Division, General Motors Corporation, LaGrange, Ill.

Hydro-Power Peaking and Pondage by Computer

C. E. HILDEBRAND
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THE hydroelectric development of the lower and middle Columbia River is unique: its exclusive development by low-head run-of-river projects is not encountered elsewhere on a river of this magnitude. From tailwater at Bonneville dam to the Chief Joseph forebay at 946-feet elevation, virtually all of the head is being developed by a series of overlapping hydro projects. A similar development is being planned for the lower Snake River up to its confluence with the Salmon River (Fig. 1). Projects existing or under construction

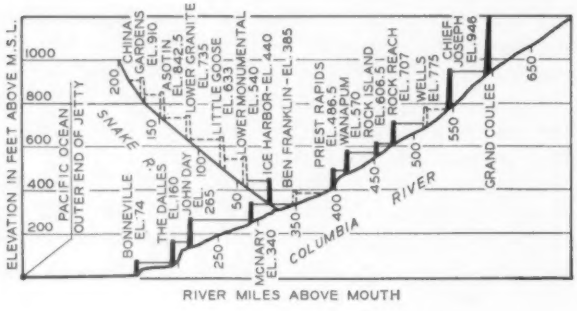

Fig. 1. River profiles, lower Columbia and Snake Rivers.

are indicated by the solid symbols; those planned for future development by the dashed symbols.

The reservoirs of these projects have limited pondage, generally less than 1 day's river flow during the low-flow season. At the same time, these projects have hydro stations with large installed capacities relative to the flow of the river. In general, the hydraulic capacity of these hydro stations is double the flow during the low-flow season. Many of the newer projects have provisions for further expansion of generating capacity.

This type of development—by hydro stations with limited pondage and large capacity—poses problems in design and operation. The power resource at each project is dependent upon the power loading and hence discharge of the next upstream project. Where the projects overlap, the head upon the upstream project is partially dependent upon the pool elevation of the downstream project.

The intelligent planning and efficient operation of these projects requires the analysis of the effects of hydro-peaking operations on reservoir and river stages. As an aid in the analysis of this complex problem, a computer program has been written. Input data to the program are basically as follows: (1) headwaters flow, (2) local inflow between projects, (3) station power loadings, (4) number of units on the line, and (5) spill (if any). Program output consists of total project discharge computed as sum of power discharge, spill and miscellaneous releases (fish ladders, lockages, etc.), forebay and tailwater elevations, and gross head on the project. These data are computed for each project for each time interval—normally 1 hour. There are two principal parts to the program. One is the method of computing power discharge and the other the flow routing procedure. The method of computing power discharge uses individual unit performance characteristics to obtain the necessary accuracy. Assumptions of average or best efficiency operation are inadequate since units are not always—or even not usually—taken off and put on the line to keep the station at best efficiency in the course of daily load swings.

The program, to be realistic, must be capable of simulating this actual operation. The unit performance characteristic includes both turbine and generator efficiencies. Transformer losses are not included. The program generation is thus equivalent to generation as metered at the generator terminals.

Discharge variations from the projects are delayed and modified by a flow routing procedure which simulates actual channel and reservoir storage. Each actual reservoir or open reach of river is subdivided into a series of incremental reservoirs. Outflow from each incremental reservoir is computed as a function of the elevation of the increment and the difference in elevation of that increment and the next downstream increment—that is, the slope of the reservoir.

The detailed computations required by the program would make it prohibitively slow were it not for the fact that both the power-discharge and flow-routing procedures are predigested. Polynomial equations are used to represent these data.

A special feature of the program is a provision for simulating centralized load-frequency control of the station power loadings. Plans are currently under way for centralized load-frequency control of the major Federal generating stations in the Columbia basin from the load dispatcher's office in Portland, Ore. The program makes it possible to test the effects of various station participation settings on station power loadings, discharge, and pondage. It is envisioned that ultimately the loading of the Columbia River projects will be directly controlled by computer. The present program could well serve as a basis for such a future computer program.

Digest of paper 60-1065, "The Analysis of Hydro-Power Peaking and Pondage by Computer," recommended by the AIEE System Engineering Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, San Diego, Calif., Aug. 8-12, 1960. Published in AIEE *Power Apparatus and Systems*, Dec. 1960, pp. 1023-29.

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The Rotating Electric Machine in an Electrical Engineering Degree Course

BERNARD ADKINS

A discussion is presented of how best to utilize the dwindling portion of the engineering curriculum devoted to the rotating machine. A course of study of electromagnetism is outlined in which the rotating electric machine is treated as a separate topic rather than as part of a unified approach to all electromagnetic apparatus.

THE rotating electric machine, which used to figure in so much detail in college courses in electrical engineering, now forms a much smaller part of the curriculum. The problem of how to deal appropriately with the subject in the limited time available was discussed recently in a British article.[1] The author rightly advocates a process of unification and points to the books which present the mathematical theory of the generalized machine.[2] The unification can, however, be made more effectively on a physical basis, and it is contended here that this provides the best starting point of an undergraduate course. The mathematical theory can be formulated after the physical basis has been established.

The students entering the 3-year degree course in electrical engineering in an English university have reached a good standard in mathematics and physics but have not necessarily made any contact with engineering. During the first year they study all branches of engineering, electrical topics occupying only about one sixth of the total time. At the end of 3 years the student should have achieved a good general understanding of the principles underlying the whole range of electrical engineering work together with a background knowledge of mechanical and other subjects. Consequently, the electric machine can only occupy a small proportion of a student's time during the course.

The rotating electric machine, in spite of the immense variety in its practical form, can be treated as a single type of apparatus, consisting of axial conductors moving in a magnetic field, which passes across a cylindrical gap between two iron cores. It must be included in the course, not only because of its great practical importance but, still more, because it provides an excellent example of the application of the principles of electromagnetism. The study of systems with moving parts is more difficult than the study of static systems, which are dealt with under the heading of "Circuit Theory," but the treatment ought to be on the same lines. In this repect, however, the normal approach to circuit theory leaves something to be desired.

In the study of circuit theory, there is a great tendency to represent a component by a symbol on a diagram and to forget that it is really an electromagnetic device. It is quite wrong to do so for a static component, and it must never be allowed to happen with the rotating machine. In the machine, because of its greater complication, the simplifications often have to be more drastic than in a static device such as an inductor, and important effects such as saturation, communication, or losses, must be ignored or dealt with in an approximate manner. Just as an approximate inductance parameter L can represent an inductor in a static system, so can the parameters of a machine be effectively used to calculate its performance.

Apart from the main types of generator and motor, there are many important electromagnetic devices, such as instruments, solenoids, and relays, which are also worthy of study, but which do not conform to the pattern of the rotating machine. Such devices are best studied by a direct application of fundamental electromagnetic principles, built on the foundation of an earlier treatment of the simpler static systems. Energy methods are very useful at this stage because they show clearly the relation between the physical action and the mathematical formulation. More general analytical methods, for example, those based on Lagrange's equations, do not form a suitable starting point, although they may be very useful for advanced work.

OUTLINE OF CURRICULUM

IT HAS BEEN PROPOSED that all electromagnetic apparatus with moving parts, including rotating machines as generally understood, should be regarded as a single group and treated by a single unified method.[3] While it is a matter of convenience rather than of principle, it is preferable, in the writer's view, to retain the rotating machine as a distinct topic, because of the simplicity of the established method based on the flux changing rule in comparison with the complication of more general methods. In particular, the application of Lagrange's equations to commutator machines is a matter of extreme complexity.

On this view, the undergraduate degree course should include the following separate but interrelated subjects, which at many points would run concurrently during the 3-year course:

A special article recommended for publication by the AIEE Educational Publications Committee.

Bernard Adkins is with the Imperial College of Science and Technology, University of London, England.

1. Fundamental principles of the electromagnetic field.
2. Static devices and circuits.
3. Systems with movable elements.
4. Rotating machines.

These subjects would provide the foundation for such topics as "Control Systems" and "Power Systems," and would run parallel with subjects based on such other physical principles as those associated with gas discharges or semiconductors.

1. *Fundamental electromagnetism.* This subject should receive more attention than it often does. In the early stages the student should obtain a clear understanding of the general properties of electric and magnetic fields, including those containing moving bodies. Later the subject can be studied mathematically in terms of vector theory.

2. *Static devices and circuits.* The circuit concepts should be related to, and derived from, the underlying field concepts, and the student should have experience in the calculation of circuit parameters. The early part of the course should include the study of lumped-parameter networks under alternating and transient conditions. Later the subject can be studied systematically using sets of simultaneous equations and matrices.

3. *Systems with movable elements.* Here the application of the electromagnetic concepts would be extended from the solution of static field problems to the treatment of interacting field sources. The topics considered under this heading would include, in addition to devices such as instruments and relays, some of the secondary problems in rotating machines.

4. *Rotating machines.* The subject of electric machines, which would for convenience also include the power transformer, is important enough to be treated on its own merits, even though the time is severely limited. The course should provide a unified treatment of rotating machines in the manner discussed in the section which follows.

THE PATTERN OF THE COURSE

THE PATTERN OUTLINED HERE is similar to that followed at present at Imperial College of Science and Technology, London, England. The focal point of any subject is the series of lectures, which define the academic content, and this is associated with laboratory work and tutorial classes. In the first year, "Applied Electricity" is one subject in a total of six, and there are two lectures per week. Assuming a 48-hour week, a student can devote to one subject, on an average, about 8 hours per week, which must include all the time spent in the lectures, tutorial classes, and laboratory, as well as the time spent on private study and report writing. In the first year, 10 lectures, or one fifth of the course of "Applied Electricity," is given to transformers and machines. In the second year, "Electric Machines" is one subject out of a total of eight, and there is one lecture per week. Thus a student in the second year can devote a total of 6 hours per week to electric machines. In the third and final year, the only specialist option is a choice between "Generation and Distribution" and "Communications." Those who opt for communications do not study electric machines at all, while those interested in power engineering have one lecture per week for half a year.

These figures are given to show how limited is the time available for the subject of rotating machines. The other three topics listed are given a good deal of attention in the other lecture courses, developing in each case from physical principles in the first and second years to a more mathematical treatment in the final year.

In the writer's opinion, the time available for rotating machines is sufficient provided that the course concentrates on essentials and adopts a unified approach. It is also important that the quantity of material in the course, measured in terms of the number of new ideas presented to the student, must not be more than he can reasonably absorb in the limited time. Finally, it must not be so theoretical that the student misses the main purpose of an engineering course of enabling him to solve real, practical problems. Many proposals, otherwise admirable, fall down in those two respects.

The 10 introductory lectures in the first year explain what the machines are and discuss the general nature of the problems which arise. The second-year course studies the physical basis of the simplifications made in establishing the general theory and applies it in a uniform manner to the three basic types: the d-c machine, the synchronous machine, and the induction motor. Most of the limited time is given to steady conditions, although a few simple transient problems are discussed. Although a full understanding of machine operation must include both the steady and transient aspects, it is better to deal with the simpler conditions first. The essential relationships between flux, current, and voltage are just the same for steady as for transient operation, and it is considered that the steady conditions provide the best means of showing clearly what these relations are. In the third year, those students who take this subject are given an introduction to the general theory, expressed in terms of differential equations, and its application to a few important practical transient problems.

THE UNIFIED APPROACH

THE SECOND-YEAR COURSE is the point at which the students have an opportunity to gain an understanding of the essential operation of the machine. The emphasis on steady operation does not mean that the presentation is on the old piecemeal basis. On the contrary, the three types are treated as examples of a generalized machine. The same simplifications that underline the general differential equations are also made in developing the simple theories applicable to steady conditions. For example, any voltage vector diagram makes use of the principle of superposition and thus refers to an ideal-

ized machine with no saturation. The attention is focussed on the region in or near the air gap and in the idealized machine the actual complicated flux distribution is expressed by a curve of flux density along an "air-gap line." The concept of leakage provides an approximate means of allowing for magnetic effects not accounted for by the main air-gap flux.

A simple example may be given to show how unification can apply at an elementary level. It has been the custom in the past to study the induction motor in terms of current-locus diagrams, but synchronous machine performance has been depicted on regulation or power factor curves. In the world of practice, however, the important characteristics of an alternator are also current-loci, as evidenced by the use of "vector meters" in power station control rooms. Yet many colleges still retain the out-of-date concept of alternator regulation. The teaching world should lead the practical world, not lag behind it. In this example, the unification has emerged as a natural development.

Whatever the type of machine, the active conductors are located near to the air gap and are connected outside the core into a relatively small number of circuits. Thus, a small number of currents, in conjunction with the known distribution of conductors, form the starting point for a study of the magnetic field set up by the currents. The first step is to determine a curve showing at any instant the magnetomotive force (mmf) across the gap at different points round the periphery. The mmf curve, which is itself a simplified concept, follows directly from the current distribution. The flux density is determined by the resultant mmf curve and is in turn used to calculate the voltages induced in the windings. For equilibrium, all the voltages in a closed circuit must add up to zero. The mechanical quantities, speed and torque, must also be brought into the theory.

A preliminary consideration of the properties of the elements which make up the machine is necessary before studying the complete machine. In particular, the action of a single winding on the magnetic system must be analyzed in some detail. The complete machine, of whatever type, is then a combination of two or more such windings. The principles involved can be fully illustrated by the three basic types, and it is not necessary to consider more complicated combinations, which require only a straightforward extension of the treatment.

Although the main line of attack is the same in all cases, some subdivision is necessary when studying the details. The magnetic system may be: (a) salient-pole type, exemplified by the d-c machine; or (b) uniform air-gap type, exemplified by the induction motor and the round-rotor synchronous machine.

The windings are of three main types: (a) field winding on salient poles or in slots; (b) a-c winding on a slotted core; or (c) commutator winding on a slotted core.

The three machine types are obtained by combining two windings: (a) and (c)—d-c machine; (a) and (b)—synchronous machine; or two of (b)—induction motor.

Third-year and postgraduate work. On the foundations laid in the second-year course a more advanced study of steady or transient conditions in any type of machine can be developed by setting up and solving the differential equations of the generalized machine. Even in the limited time available in the third-year course, however, it is important to do more than merely manipulate the equations, and it is essential to include examples of their application to real problems on real machines. It is a frequent criticism of writings on matrix and tensor analysis that they provide no indication of how to apply the method, or even whether it can be applied to practical work. An undergraduate course must not have this defect. A postgraduate course provides a fuller opportunity for developing both the theory and its application.

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Foiled by Aluminum

Fast-spreading grass and brush fires have long been a menace to the pole lines of electrical utilities. To reduce the hazard, Washington Water Power Company, Spokane, Wash., hit upon the idea of wrapping the base of the pole with quilted heavy duty aluminum foil.

A Semiconductor Variable-Speed A-C Motor Drive

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A recently developed static variable-frequency variable-voltage power supply operates directly from a polyphase a-c power line to drive a synchronous motor. Speed regulation is perfect because of the synchronous motor constant-speed characteristics. Use of silicon-controlled rectifiers, together with unique logic circuitry, results in an extremely simple and reliable drive system.

AN INCREASING NEED is developing for reliable, variable, low-speed electric drives in adverse environments where the complexity of gears or other mechanical transmissions cannot be tolerated. These environments in general preclude the use of d-c or a-c drive motors with slip rings or commutators because of the brush problem. Typical of these applications are drives for accurately orienting solar collectors and antennas on satellite or space vehicles, nuclear reactor control rod drives, and machine tool spindle or slide feed drives in high-temperature environments. Typical speed requirements range from 300 to 0.02 rpm. These applications can subject the drive motors to vacuums up to 10^{-10} mm Hg, temperatures up to 800 F, pressures up to 2,500 psi, as well as nuclear radiation separately or in combination. By separating the motor from its associated circuitry, only the motor need be subjected to these environments. It is obviously imperative to keep this drive motor as simple and reliable as possible. Several types of a-c motors fit well into this category. Selection among them depends upon the particular application. They include the permanent magnet and the reluctance synchronous motors. These motors, however, are inherently incapable of very low-speed operation and certainly not variable-speed operation when energized from 60- or 400-cps power, for example.

To provide the link between the power line and motor, a polyphase semiconductor frequency-reducer technique has been developed and is the main subject of discussion here. This reducer can produce variable-frequency reversible phase for speed adjustment and motor reversal. With a synchronous motor, the speed can be set at any value and it will remain constant regardless of variations of load or power line voltage or frequency without the need for a speed-control loop. The frequency reducer itself is also an "open loop" device depending only on the stability of its frequency reference for output frequency regulation. Exact synchronism can be maintained between two or more motors operating from two or more sources at the same or different frequencies if a common frequency reference is used with the frequency-reducer units supplying each motor. A number of inherent advantages and additional capabilities of the reducer are described later in this article.

SYSTEM DESCRIPTION

THE POWER-HANDLING CIRCUIT of the frequency reducer consists of silicon-controlled rectifiers arranged in a configuration of the cycloconverter family. The advent of small high-power silicon-controlled rectifiers allows compact, rugged packaging of this power circuitry. The control and firing logic for the power-switching circuit is the key to the simplicity, compactness and reliability of operation. This logic can easily be complex enough to require more volume than that of the entire power circuit. Fig. 1 is a block diagram showing the three major components of the frequency reducer: the reference-wave generator, the firing and control logic, and the cycloconverter. The reference-wave generator produces a sinusoidal output with phases and frequency corresponding to the phases of the motor and the speed desired. Adjustment of the reference-wave amplitude produces directly corresponding amplitude changes in the output of the cycloconverter. Change of phase sequence in the reference-wave generator produces reversal of the motor connected to the cycloconverter. Because of the lack of a gear reduction, most applications require a continuous electrical holding action of the drive motor when it is not running. The reference-wave generator can provide a fixed output on each phase with

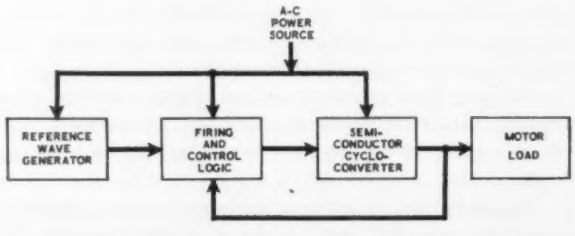

Fig. 1. Variable-speed a-c motor drive block diagram.

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The authors wish to express their appreciation to J. E. Murray, E. J. Yohman; and to the management of Thompson Ramo Wooldridge Inc. for their contributions.

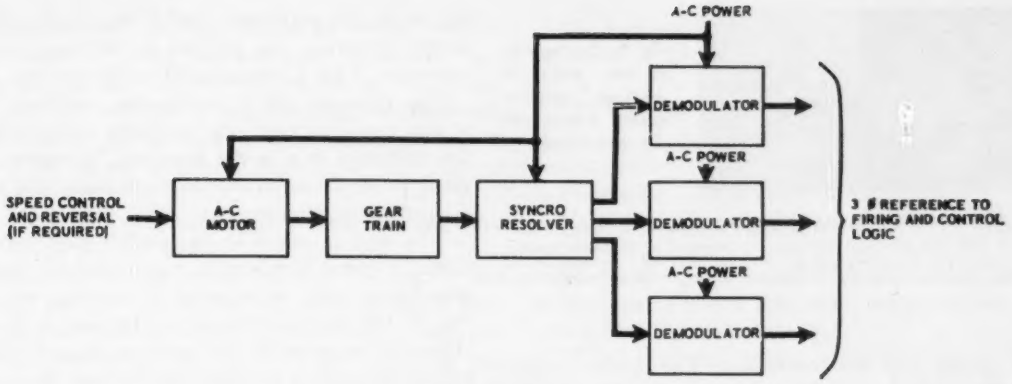


Fig. 2. Typical reference-wave generator block diagram, for 3-phase load.

magnitude and polarity corresponding to that of the last instant of motion prior to stopping.

Reference-wave generators can be either completely static or electromechanical. In order to meet the requirements of polyphase outputs over a wide frequency range, with the ability to maintain relative magnitudes and polarities between phases at zero frequency, an electromechanical approach is by far the simpler. One method which is quite satisfactory is shown in Fig. 2. Here a small motor and gear train, operating from the power line, drives a syncro also excited from the power line. The outputs are at power-line frequency, polyphase modulated at low frequency by the rotation of the motor and gear train. Each phase is demodulated, producing polyphase low-frequency waves for the input to the firing and control logic. For variable-speed applications, a 2-phase servo motor can be used to generate the wave and for fixed low-speed application a suitably geared reversible synchronous timer motor is satisfactory. Change of phase sequence is accomplished by electrically switching phases or by reversal of the reference motor. The syncro can be of the modified Lundell configuration if a completely brushless control system is required.

The firing and control logic uses magnetic and semiconductor components to perform the function of properly firing the appropriate silicon-controlled rectifier in the cycloconverter in order to reproduce the reference wave at the output. Fig. 3 is a block diagram of the essential elements of this circuit. Information from the reference-wave generator, the a-c power line and the output current of the cycloconverter is used by the selection and firing logic to determine the sequence and firing times of the cycloconverter silicon-controlled rectifiers. All of this information is necessary in order to handle regenerative braking, reversal, and variable power factor presented by the drive motor load. The firing signal is amplified in the process and shaped to present a spiked pulse to the associated silicon-controlled rectifier.

The cycloconverter is a static device consisting of silicon-controlled rectifiers and commutating reactors. Fig. 4 is a schematic diagram of a 3-phase to 3-phase cycloconverter. It uses 18 silicon-controlled rectifiers and three commutating reactors. Each phase of the drive motor is connected to two 3-phase half-wave rectifiers on the power line. The two rectifier groups are of opposite polarity. By using silicon-controlled rectifiers, the magnitude and direction of the real and reactive power transferred between the power line and the individual

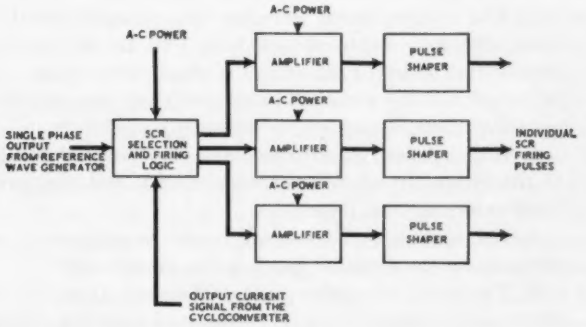


Fig. 3. Block diagram for typical firing and control logic, 3-phase load.

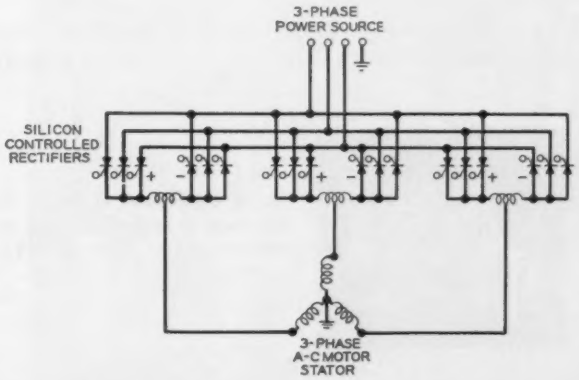


Fig. 4. SCR cycloconverter, 3-phase to 3-phase.

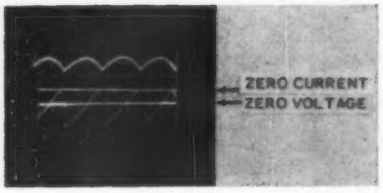


Fig. 5. Oscillograms of one phase of unfiltered zero-frequency output current and voltage.

Load current (*upper curve*), 2 amperes per division; load voltage (*lower curve*), 63 volts per division; reference frequency, d-c; ripple frequency, 180 cps; time scale, 2 milliseconds per division. (Voltage waveform should be inverted about its zero line to indicate its proper phase relationship.)

motor phases can be controlled. The low-frequency wave in a particular motor phase will require only the positive group of rectifiers, for example, during a half cycle of the lower frequency current. For the other half cycle, only the negative group of rectifiers on that motor phase will be used. In this way, a low-frequency current wave may be produced in each of the drive motor phases.

TYPICAL CHARACTERISTICS

A TYPICAL frequency-reducer motor drive is rated at 30 kva with a 480-volt 3-phase 60-cps input and a 220-volt 3-phase d-c to 15-cps output. This represents the upper limit of capacity with this configuration using natural convection air-cooling techniques and presently available SCR (silicon-controlled rectifier) units. By operating from a 6-phase input, by using parallel-connected SCR units, by providing better cooling, or by utilizing future higher power rated SCR units, this rating can be increased. Units of ratings down to 1.5 kva have been made.

This type of drive is capable of handling loads of varying power factors because of its ability to operate over both rectification and both inversion modes with the concomitant bilateral power transfer capability between source and load. Regenerative braking is inherent in the design due to this inversion capability.

Fig. 5 shows one phase of a typical unfiltered zero-frequency output into a 3-phase reluctance synchronous motor. The load voltage and current have a 180-cps ripple. The load voltage consists of both positive and negative parts with a net positive output, typical for this circuitry.

Fig. 6 compares a filtered single phase of load current to the reference voltage waveform used in generating it. In this particular case, it should be noted that a slight distortion was present at the zero point of the reference. This is reproduced in the output.

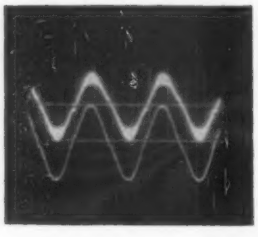


Fig. 6. Oscillograms of filtered single phase of load current and the reference-voltage waveform used in generating it.

Reference voltage output (*upper curve*), 5 volts per division; load current (*lower curve*), 2 amperes per division; frequency, 0.5 cps.

The necessity for a continuous reference waveform is not required since the circuitry essentially samples the reference at discrete intervals. However, this sampling point varies so that in most cases it is best to use a continuous reference.

This type of motor drive yields a good current waveform. Typical single-phase load current and voltage waveforms, with no attempt at filtering, are shown in Fig. 7. The load in this case is the same reluctance synchronous motor as for the previous figures. The 180-cps ripple is evident in both waveforms. Also noticeable is the synthesis of the voltage waveform, indicating transfer of conduction between positive and negative groups of output silicon-controlled rectifiers at zero current. The output waveform is dependent upon the input frequency, desired output frequency, number of input phases, and the power factor of the load. For a particular application, each of these will be either dictated or selectable.

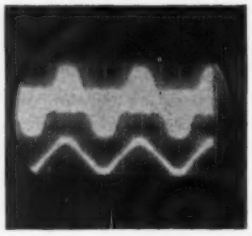


Fig. 7. Oscillogram of typical single-phase unfiltered load voltage and current waveforms.

Load voltage (*upper curve*), 63 volts per division; load current (*lower curve*), 5 amperes per division; frequency, 0.5 cps.

ADVANTAGES

MANY desirable features are inherent in this frequency-reducer motor drive. Some are, of course, available in other systems, but it is believed that the combination of the following advantages is not present in other drives:

1. The output waveform, speed, voltage or current, and direction of rotation are independently variable.
2. The output speed may be continuously variable from zero to a value approaching that of the power-supply frequency. This range is dependent upon the reference and the motor. The output frequency is independent of the source in the operating range.
3. High efficiency, well over 90%, is possible because of the simplicity of the power circuitry and the auxiliary reference and logic.
4. The system load presented to the power source, as reflected by the variable speed drive, is balanced.
5. The drive is capable of handling any types of resistive and reactive loads, even those of variable power factors, throughout the complete rectification and inversion modes because of its inherent bilateral power-transfer capability.

6. Synchronizing and paralleling of drives is easily accomplished by using one or more references even though the phases and/or frequencies of the power sources to each individual unit are different and variable. Real and reactive load division between units are obtained by phase synchronization and cross-current coupling.

7. Reliability of this drive is potentially excellent due to the simplicity and choice of components.

8. Commutation problems inherent in similar systems, particularly d-c systems, are not a problem here.

9. The conventional motor designs used in conjunction with this variable-speed drive are brushless and adaptable to adverse environments where extreme reliability and ruggedness are requisite.

10. Radio-noise interference generated by this drive, without any compensation, is much less than many other types, especially those operating from d-c supplies.

11. More than one power source can be tied to one variable-speed drive to increase reliability of service should one source fail.

12. No drift or phase-angle error of the output will occur when the drive motor is at rest.

13. Starting, stopping, and reversal of direction of rotation is simple, and no discontinuities of output occur.

14. Malfunction of individual SCR circuits in the drive can occur with a relatively small degradation in performance. It should be noted that each output phase is essentially independent of the others.

15. Transient response between reference and output of the drive is in the millisecond range.

16. System growth potential is excellent due to the separation of power and logic functions and the flexibility noted previously.

17. The present drive is essentially an open-loop system with no stability problems. For special purposes, output voltage or current regulation can be provided easily.

18. Fail-safe features are provided throughout the drive; e.g., a reference-wave generator motor failure may have a manual override.

19. Speed regulation of this system is perfect with synchronous drive motors.

20. Regenerative braking is inherent in the design.

21. Natural convection cooling is utilized.

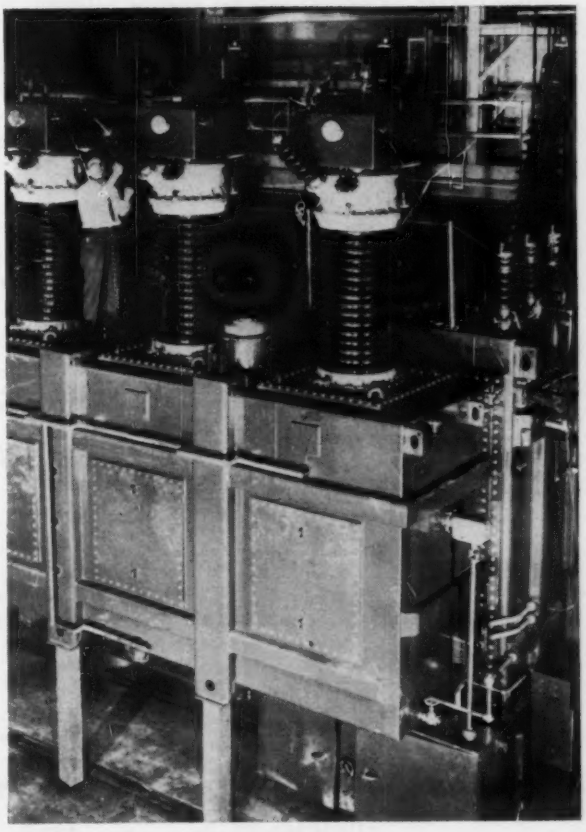
200-Mva Transformer with New Load Tap Changer

A 200-mva power transformer with resistance-switched high-voltage load tap changer was shipped by the Westinghouse Electric Corporation to New York State Electric and Gas Company's Gardenville, N. Y., station. The forced-air-cooled unit will be used between systems to step down voltage from 230 to 120 kv.

It features a novel high-voltage load tap changer, type *URH*, which serves two purposes: increased contact life achieved by in-phase resistance-type transfer switch, and reduced weight and shipping length. The unit is 10% lighter than conventional transformers with tap changers using series transformers and preventive autotransformers. In addition, the shipping length was reduced by 25%.

Elimination of both the series and preventive autotransformer also results in a decrease in losses of the over-all unit. This permits further reduction in size, because the amount of cooling supplied in the form of added radiators was reduced.

The selector switch is attached to the lower end of the large porcelain bushing and contains a number of parallel contacts. This arrangement makes the best use of insulation structure and reduces the size of the load tap changer. The transfer switch, in the compartment on top of the large bushing, saves much space otherwise required between various parts. The switch cannot be stopped between positions as it is functioning. All connections, both mechanical and electrical, between the transfer switch and selector switch are made inside the porcelain bushing.



Planning Generation Expansion by Digital Simulation

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SYSTEM planning programs using simulation are designed to meet the objectives of long-range planning studies, which include an accurate evaluation of the economics of alternate expansion patterns. The economic effect of unit size, the worth of greater than normal unit reliability, and variations in system service quality all have been studied.

Results presented are for estimated cost structures for one system, Public Service Electric & Gas Company, with a present peak demand of 2,600 mw (megawatts), currently expected to quadruple in about 20 years.

The study begins with the exact complement of units existing on the Public Service system and its interconnected neighbors. This complement is expanded stepwise in a realistic gradation of size. The base pattern expands with units ultimately reaching 500 mw, about 5% of the system size. Two other patterns expand with larger units, reaching 1,000 mw and 1,500 mw. All patterns are terminated by costing only that portion of the final unit required by load growth at the end of the 20-year study.

Fig. 1 shows the present worth of all future revenue requirements (PWAFRR) plotted against ultimate size. The standard deviation shown for PWAFRR is caused in large part by the random construction delays simulated and by the variations allowed from trend line annual peaks in the several games. The standard deviation was reduced by 50% for the 500 mw pattern when no construction delays were allowed and all annual peaks were taken exactly on trend.

Large units cause severe transmission cost penalties by unduly concentrating generation. These penalties cause an upturn in the curve of Fig.1 at about 1,000 mw. With the transmission cost differential removed, results indicate the optimum size to be well above 1,500 mw.

Changes in forced outage rate affect reserve requirements, installation dates, production costs, and hence PWAFRR. The present dollar effect of changing outage rate on new units has been studied by varying the parameter T_u, average up time, or its inverse, failure rate, on new units about a base case of 96 days. Results are shown in Fig. 2.

It is interesting to note that an average up time of 192 days results in a decrease in PWAFRR of about $16 million. The same decrease in PWAFRR would be obtained by decreasing each unit's first cost by $2.20 per kilowatt, which means that this improved outage performance is worth $2.20 per kilowatt on each new unit. On the other hand, a T_u of 48 days adds about $11.70 per kilowatt on each unit's first cost in the base case. This is equivalent to $1.40 per kilowatt per year one could afford to spend on additional maintenance to bring the 48-day average up time up to 96 days.

Simulation studies support the concensus that single boiler units are more economical than twin boilers. Although twin boiler units have the advantage of more flexible maintenance scheduling, results indicate that they are not worth the additional first cost.

In all of the patterns discussed thus far, new units were installed to maintain a consistent level of service quality by computing each month a parameter t from the statistical distribution of reserve margin. This parameter is related to the probability of load loss in the month in question. By specifying t, one specifies a tolerable limit on probability. When this probability level is exceeded, new units are added. In general, when t is low, probability of load loss is high. Studies were run with different levels of service quality. Results indicate that it may be possible to incur an unduly severe penalty by imposing too strict a level. On the other hand, only moderate costs are incurred to raise a poor level to an acceptable one. Curves are presented to show the PWAFRR for system expansion with different service quality levels.

Digest of paper 60-1194, "The Effect of Unit Size, Reliability, and System Service Quality in Planning Generation Expansion," recommended by the AIEE System Engineering Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 9-14, 1960. Published in AIEE *Power Apparatus and Systems*, Feb. 1961, pp. 1042-50.

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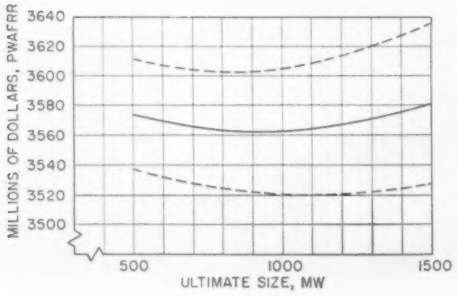
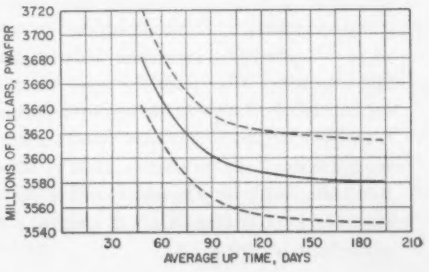


◄ **Fig. 1. PWAFRR for patterns expanding ultimately to units of various sizes. One standard deviation from mean shown dotted.**



► **Fig. 2. PWAFRR for patterns having new units with different average up times between forced outages. One standard deviation from mean shown dotted.**

An Analysis of Pinhole Punctures in Underground Cable Jackets

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FELLOW AIEE

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Analysis of pinhole phenomena reveals possibility that high voltage may develop across cable insulation although the underground secondary system has no direct connection to overhead lines. Experience has shown that lightning arresters across the system bus will materially reduce cable failures. They will also limit the transient voltages caused by switching and similar surges.

IT IS not an uncommon occurrence to find pinhole punctures in the jackets of shielded or metallic-sheathed underground cables, the pinholes often occurring in a row a few inches apart. Sometimes a failure of the cable insulation takes place in the region where the pinholes occur; in many cases, there are no such accompanying failures of the cable insulation. Fig. 1 shows a number of such pinholes in the jacket of a shielded underground cable. Note that although the shield at a spot surrounding the largest pinhole has been completely destroyed by heat, there was no accompanying failure of the cable insulation. This article offers a possible explanation of these phenomena, based on the distribution of lightning earth currents and the ensuing distribution of earth potential.

The distribution of earth currents and earth potential under lightning strokes has been analyzed and explained by L. V. Bewley[1]. The following analysis is based on the section, "Physical Concept of Multivelocity Waves."

Fig. 2 shows the voltage and current distribution resulting from a lightning wave on an overhead line. Since the earth has distributed resistance, this is simulated by an earth resistance network. When the toe of the lightning wave reaches a unit of the line capacitance (Fig. 2) the voltage across the capacitance is zero, since with a stepped voltage-pulse across a capacitance, at the instant, it cannot support any voltage. Hence, with a very steep wave front, the entire voltage of the lightning wave is consumed by the ground resistance, as shown by the curve e_r, when time $t = 0$, and e_c, the voltage between line and ground, is zero. However, as the wave passes along and the voltage becomes more nearly constant as shown, the current in the ground redistributes itself, its flow lines finally becoming practically parallel to the surface of the ground, as shown by the arrows. The vertical component of the current disappears and the voltage across the ground becomes zero, as shown by the point "Final e_r," curve e_r, and the full line potential is then across the line capacitance, as shown by "Final e_c," on curve e_c. The region in which the earth currents flow is called the "deep earth ground" and its distance from the overhead line may be as high as 2,000 feet (Bewley[1] p. 177).

ANALYSIS OF A TYPICAL INSTALLATION

THE CONDITIONS SHOWN in Fig. 2 are for an open smooth line. In the discussion that follows, a typical installation is cited in which a 115-kv high-voltage overhead line supplies a 13.8 kv substation which includes a step-down transformer protected by a lightning arrester, and a 13.8-kv underground distribution system.

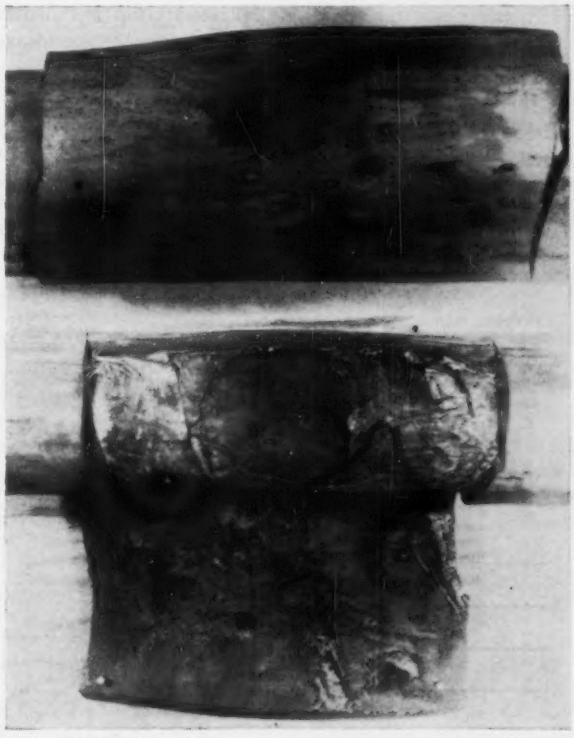

Fig. 1. Pinhole punctures in cable jacket and damage to shield. Both views show same fault: *(top)* with jacket just cut away; and *(bottom)* with the jacket bent down to show shield.

This article is based on a report submitted to Task Group 3-30 under Subcommittee no. 3 of the AIEE Insulated Conductors Committee.

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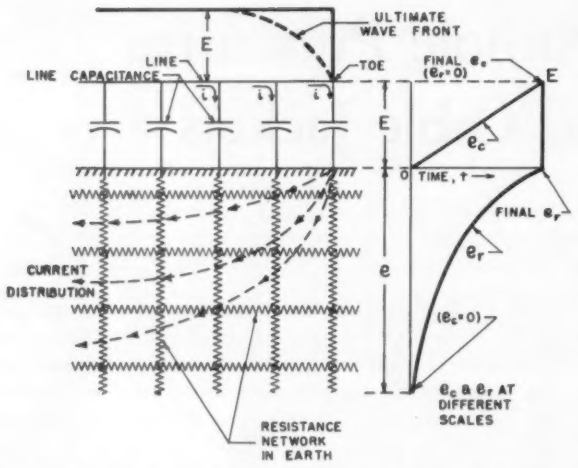

Fig. 2. Voltage relations and earth-current distribution with lightning.

However, the basic phenomena are very similar to those for the high-voltage overhead line shown in Fig. 2, inasmuch as the lightning currents are distributed through the ground and produce voltage distributions in the system capacitances similar to those shown in Fig. 2.

The conditions under consideration are shown in Fig. 3 (a). A 115-kv line supplies a 13.8-kv substation through two 115/13.8-kv transformers, only one being shown. A 13.8-kv shielded, single-conductor underground cable is connected to the bus bars as shown. A lightning arrester (LA), designed to chop a lightning wave to 400 kv, is connected between the line conductor and the station ground G. In the transformer, there is leakage resistance R_t between primary and secondary, which is usually high, capacitance C_t between the primary and secondary, and capacitance C_g between primary and ground G, both of which are relatively small. L_t is the equivalent transformer inductance, some of which is in the primary, and some of which is in the secondary, as shown in Fig. 4.

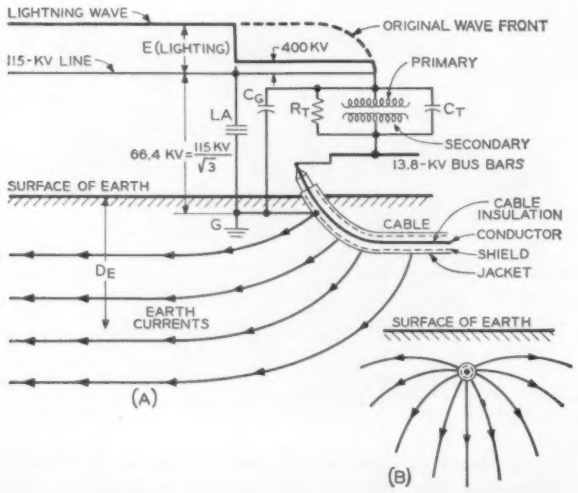

Fig. 3. Lightning wave and typical substation-cable installation.

Because of the small diameter of the cable, the earth currents are highly concentrated in the region immediately surrounding the cable, as shown by the profile view, Fig. 3 (b). This produces a high-voltage gradient in the earth adjacent to the cable jacket.

Fig. 4 shows a simplified equivalent diagram of Fig. 3 (a). Note that the full lightning voltage E, assumed to be 1,000 kv, is impressed between the conductor and the "deep earth ground." Moveover, between the line conductor and deep earth ground there is a series circuit consisting of the equivalent transient circuit of the transformer, the capacitance C_c of the cable with its leakage resistance R_c, and the capacitance C_j of the jacket with its leakage resistance R_j. The voltage between the overhead conductor and station ground is held to 400 kv by the lightning arrester. Thus, the voltage between station ground and the deep earth ground, and hence the voltage between the shield and the deep earth ground is equal to E — 400 kv. With the assumed value of line potential, $E = 1{,}000$ kv, this is equal to 600 kv.

At the instant that the lightning wave toe reaches the transformer primary, as shown in Fig. 3 (a), there will be no voltage across the transformer, the cable insulation, and the jacket since, with very steep voltage wavefront, their capacitances C_t, C_c, and C_j cannot support any voltage. Between the line conductor and cable shield there is 400 kv, the cutoff voltage of the lightning arrester. There is little series resistance in this circuit so that the voltage between the shield and line conductor, as well as that across the transformer, rises almost immediately to 400 kv. Initially, this voltage divides between the transformer and the cable insulation, inversely as their capacitances. The transformer capacitance between windings C_t is very small, and the capacitance of the cable is relatively large, so that most of the 400 kv will appear across the transformer. The 600 kv will appear across the jacket and ground resistance in series. However, this voltage will build up across the jacket quite rapidly in accordance with a voltage e_c across a capacitor C, building up ultimately to the steady impressed voltage E [Fig. 5 (b)] when this voltage is connected suddenly across capacitance and resistance in series [Fig. 5 (a)]. Thus, a very high voltage can

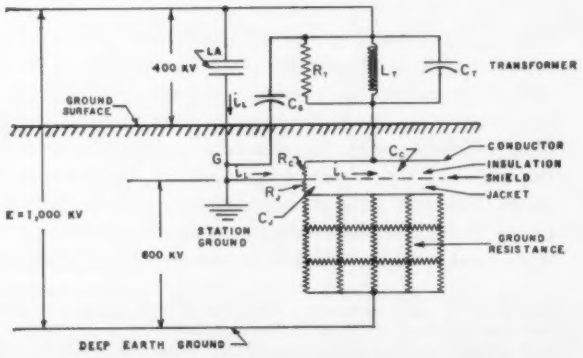

Fig. 4. Equivalent circuit of line, substation, and cable.

build up across the jacket, theoretically 600 kv, which is ample to produce pinhole punctures in the jacket, which has relatively low dielectric strength. These punctures have been found along the outside wall of the jacket in contact with the ground or conduit, but there were no corresponding pinholes or punctures in the insulation.

The high voltage developed across the jacket may be explained in a slightly different manner. Assume that the lightning charge on the line is positive. This charge, in flowing to meet its negative counterpart in the ground, goes through the lightning arrester, to the station ground, to the cable shield where it finds a comparatively low impedance path, to meet the negative charge coming up through the ground. The path of the charge is shown by the arrows i_L in Fig. 4. The jacket insulation, being in the path of the charges, is subjected to high lightning voltage, which may be nearly equal to the difference in potential between the station ground and the deep earth ground. Under the assumed conditions this difference in potential is equal to 600 kv.

These phenomena have occurred when the cables have been installed in nonmetallic ducts. This does not change the basic problem, however, for this merely interposes or adds series capacitance and resistance to the ground resistance (Fig. 4). Moreover, at the high voltage involved, corona can readily form between the duct wall and jacket wall where air spaces occur.

After the wave front has passed (Fig. 3), the voltage of the lightning wave, that is, the tail of the wave, decreases slowly, in terms of the time of the steep wave front which is of the order of 1 to 1½ μsecs. For example, Bewley[1] states (p. 112): "The total duration of the lightning stroke may last for a second or longer." Thus, with a 1½ μsec wavefront, the ratio of the wave duration of 1 second to the wavefront is $1/(1\frac{1}{2} \times 10^{-6}) = 667{,}000$. This gives time for the voltage across each of the capacitors C_t, C_c, and C_j in Fig. 4 to rise part way at least, or even practically to the full value of the transient voltage of the stroke, in accordance with e_c in Fig. 5 (b). These transient voltages are 400 kv and 600 kv under the assumed conditions of Fig. 3.

Failure of the cable insulation frequently accompanies the pinholes, particularly when they produce burning action in the jacket. One explanation may be that the heat on the shield evolved by the lightning current or by the jacket failures may injure the cable insulation, resulting in failure. It is also possible that due to leakage, as through the transformer, or elsewhere, the voltage across the cable insulation may build up ultimately to high values, such as is shown in Fig. 5 (b). In the foregoing analysis a single lightning stroke has been assumed. It is well known that a lightning discharge often consists of multiple strokes or several successive strokes, up to 17 strokes (Bewley[1], p. 112). Thus, if the first stroke does not build the voltage up to high values, in accordance with the foregoing analysis, its initial effect may be augmented by several following strokes.

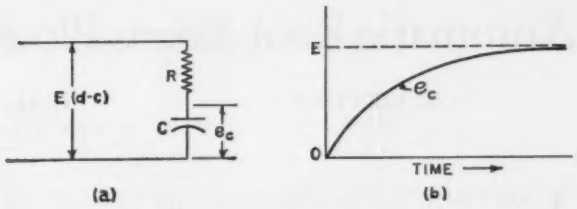

Fig. 5. Rise of voltage in an R-C circuit.

CONCLUSION

The foregoing is necessarily an oversimplified analysis. The system can only be represented in a general way by the simple diagrams of Figs. 3 and 4. For example, the overhead line and underground system extend over a wide area and there are leakage resistances and distributed capacitances that are not readily shown on a simple diagram. The lightning strokes usually are not single, simple ones flowing in a single path, but usually are multiple, taking devious paths through the earth and the electrical system. However, we believe that the general conditions by which lightning can produce the failures in underground cable jackets and insulation are in accordance with the basic phenomena which have been described. At least the overhead and underground systems offer opportunities for the described effects to occur.

Two remedies are suggested. The high voltage across the jacket comes from the difference in potential between the station ground and the "deep earth ground." This voltage may be reduced to small values by making the resistance of the station ground very low, by driving deep grounds and by other usual means, such as connecting together the ground pads of nearby substations, etc. Also, if a ground wire is laid in the ducts along with the cables and connected to the station ground, high earth voltages cannot develop across the jacket, as a study of Fig. 3 will show.

The foregoging theory and analysis have, we believe, been confirmed by our experience. We know of systems having low station ground resistance in which grounded conductors have been laid alongside the cables in troughs or in ducts. There have been no jacket failures at all, and cable insulation failures have been few or nonexistent.

REFERENCE

1. Traveling Waves on Transmission Systems (book), second edition, L. V. Bewley. John Wiley & Sons, Inc., New York, N. Y., 1951.

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Automatic Root-Locus Plotter Using an Analog Computer

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A METHOD has been developed for plotting root locus automatically by means of an analog computer. The control ratio of a feedback control system is given by

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)} \tag{1}$$

The response of the closed-loop system is determined by the roots of the characteristic equation:

$$1 + G(s)H(s) = 1 + \frac{K(s - z_1)(s - z_2) \ldots (s - z_w)}{(s - p_1)(s - p_2) \ldots (s - p_v)} = 0 \tag{2}$$

A plot in the s plane, of all possible roots of this equation, as K is varied from zero to infinity, is the root locus. Equation 2 can be manipulated to the form

$$G(s)H(s) = -1 = 1 \angle (1 + 2m)180° \tag{3}$$

where $m = \pm 1, \pm 2$. From equation 3, the angle condition is defined as

$$\angle G(s)H(s) = (1 + 2m)180° \tag{4}$$

For any value of s, the factors s–z and s–p of equation 2 are complex numbers which have magnitudes and angles. The sum of the angles from the poles minus the angles from the zeros to a value of s in the s plane, gives the angle of $G(s)H(s)$. For values of s on the root locus, the correct multiple of 180° minus the angle of $G(s)H(s)$ is zero. However, for values of s which are not an the root locus, the difference is not zero and can be expressed by

$$(1 + 2m)180° - \angle G(s)H(s) = E \tag{5}$$

The angle E represents the error in satisfying the angle condition. The root locus plotter uses the error signal obtained from equation 5 to drive a type 1 servo system. The system corrects the angle of the generated variable s until the error E is nulled. The resulting values of s satisfy the root locus condition and are plotted. A functional block diagram of the automatic root locus plotter is illustrated in Fig. 1, where I represents the integrator, R the resolver, and IR the inverse resolver.

A change of variable is necessary for the operation of the computer as a feedback system to obtain the root locus. The variable s is formed by summing an initial value s_0, which is known to lie on the locus, with an increment Δs so that $s = s_0 + \Delta s$. The computer is used in a control system such that it utilizes the error or actuating signal E, with the polarity characteristic, to rotate the vector Δs clockwise or counterclockwise.

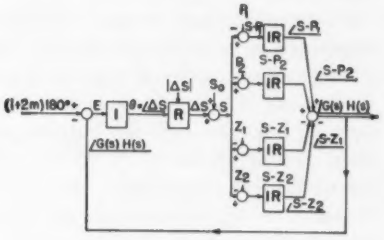

Fig. 1. Functional block diagram of the root-locus plotter.

The command input shown at the left in Fig. 1 is the angle $(1+2m)180°$, which must be met in order to obtain the root locus. A second input is the arbitrary value $|\Delta s|$ which is fed into the resolver. The resolver also has an angle input, θ. The function of the resolver is to change the polar form $\Delta s = |\Delta s| \angle \theta$ into its rectangular components $\Delta s = \Delta\sigma + j\Delta\omega$. The values s_0 and Δs in rectangular co-ordinates are added to obtain the value of s. All factors $(s-p)$ and $(s-z)$ of $G(s)H(s)$ are then formed in rectangular co-ordinates by means of summers which add the real and imaginary parts of each factor respectively. For each factor the real and imaginary parts are fed into an inverse resolver which generates its angle. Thus, all poles and zeros of $G(s)H(s)$ are converted into polar form and their respective angles are fed into a summer. The sum of the angles due to the poles minus the sum of the angles due to the zeros give the angle $\angle G(s)H(s)$. This quantity is compared with the command input $(1+2m)180°$. The difference between these two quantities is the actuating signal E. The integral of E produces the angle θ which is used by the resolver to rotate Δs in a direction which reduces the size of E. The integral of E continues to increase, producing a larger angle θ, until E becomes zero. The value of s is then a correct point of the root locus. If Δs starts from zero and is increased continuously, the value of s takes on a series of values which satisfy the angle condition. They are, therefore, points on the root locus and can be plotted on a recorder. Each branch of the root locus starts at an open-loop pole and ends at a finite zero or at infinity.

The method of root-locus plotting described here has the advantage of speed of operation. The pole and zero values are set into the computer by means of potentiometers. Thus families of curves can be obtained readily. This is advantageous when the open-loop characteristics are changing. The system requires one more resolver than the total number of poles and zeros of the open-loop transfer function.

Digest of paper 60-1186, recommended by the AIEE Feedback Control Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill. Oct. 9-14, 1960. Published in AIEE *Applications and Industry*, Jan. 1961, pp. 523-27.

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Tertiary Windings in Autotransformers

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AUTOTRANSFORMERS in power systems are usually Y-connected and commonly have delta-connected tertiary windings. Is the tertiary winding needed? If needed, what should be its size? These are two questions to consider when applying an autotransformer.

Sometimes the tertiary winding is not needed and may be a liability. This is particularly true of low coratio units, the applications offering the largest benefit from the use of autotransformers. An analysis of the need of a tertiary winding involves its three uses:

1. The tertiary winding may carry load at a third voltage. Sometimes this may justify its inclusion.
2. The tertiary winding may be needed to stabilize the neutral when unbalanced single-phase line-to-neutral loads are served. This purpose can usually be avoided. If loads of this type must be served, the neutral might be stabilized by some other means, such as carrying a neutral conductor through from the system source.
3. The tertiary winding may be used to suppress third-harmonic voltages by carrying third-harmonic exciting current. Generally this is an inadequate reason for specifying a tertiary winding. The third-harmonic component of exciting current can be supplied through a neutral connection to the system source or a grounding transformer. Even a ground return circuit may be adequate. A modern core-type unit with grain-oriented steel has very low third-harmonic exciting current.

If a delta-connected tertiary winding is included, it should not be limited in size to 35% of the size of other windings. It should be large enough to withstand short-circuit currents to which it may be subjected. If the tertiary-winding terminals are brought out, its size should be adequate to withstand a short circuit at these terminals. Frequently, a minimum-size tertiary is not large enough. Calculation of short-circuit current of this type involves the positive-sequence impedances of the autotransformer and of the connected systems.

If the terminals are not brought out, the problem is less serious, but there is still a possibility of excessive fault current flowing in a delta-connected tertiary winding. A line-to-neutral fault on either the high- or low-voltage system, or both, will produce zero-sequence current, part of which circulates in the tertiary winding.

Steps in calculating the possible magnitude of this current include

1. Determination of the positive and negative sequence impedance of the autotransformer and of the high- and low-voltage systems.
2. Determination of the zero-sequence impedance of the high- and low-voltage systems, the high- and low-voltage circuits of the autotransformer, and the neutral circuit of the autotransformer.
3. Calculation of the line-to-neutral fault current.
4. Segregation of the zero-sequence component of the fault current.
5. Separation of the zero-sequence component into its parts to determine how much flows in the autotransformer neutral circuit.
6. Comparison of this part of the zero-sequence current with the current rating of the delta-connected winding to determine how many times rated current may be imposed on the winding.

The most severe circulating current will usually occur in the case of simultaneous line-to-neutral faults on the same phase of both the high- and low-voltage systems. System grounding at other places will relieve the autotransformer of part of the zero-sequence fault-current. Lowering the ground impedance of the systems reduces the neutral current in the autotransformer.

Determination of the zero-sequence impedances is the most illusive part of the calculation. Sometimes the zero-sequence impedance of the system can only be roughly estimated. In the autotransformer the zero-sequence impedances bear some relation to the positive-sequence impedances. If the autotransformer is of the shell type or consists of a bank of three single-phase units, the zero-sequence impedances are equal to the corresponding positive-sequence impedances. However, in a core-type 3-phase unit, the zero-sequence impedances are lower than the corresponding positive-sequence impedances. For the purpose of estimating the probable zero-sequence impedances of a normally constructed 3-phase core-type power autotransformer, the following rules have been deduced from the analysis of a number of designs of units ranging from 34.5 to 230 kv and having coratios from 0.167 to 0.8:

The zero-sequence impedance of the high-voltage circuit, $\%IZ_{0H}$, is about 0.8 times the positive-sequence impedance, $\%IZ_{H\text{-}L}$. In individual units the value may vary from 0.65 to 0.9, with 0.8 times $\%IZ_{H\text{-}L}$ a fair average to use. The zero-sequence impedance of the low-voltage circuit, $\%IZ_{0L}$, can be taken as zero. It may be either positive or negative in value ranging from -0.2 to $+0.2$ times $\%IZ_{H\text{-}L}$. Zero is a convenient average to use. The zero-sequence impedance of the neutral circuit, $\%IZ_{0N}$, including the tertiary winding, is largely dependent on the coratio of the autotransformer. It can be estimated by the empirical equation $\%IZ_{0N} = K \times \%IZ_{H\text{-}L}$, where $K = 0.5\ (\text{coratio})^{-1.9} - 0.3$.

Digest of paper 61-13, recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, Apr. 1961, pp. 78-85.

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Plastic Coatings For Electrical Insulation

W. R. PASCOE

A recently developed technique known as the fluidized bed coating process makes it possible to combine the best features of plastics and metals in almost any configuration. The three coatings most frequently used in the electrical industry—cellulosic, vinyl, and epoxy—are described and compared.

MATERIALS SELECTION frequently requires compromises that may reduce design efficiency and increase cost, and may even necessitate a complete redesign. Any electrical engineer who has been faced with this problem will be interested in a new technique, called the fluidized bed coating process, that makes it possible to combine the best features of plastics and metals in practically any configuration. The advantages of a solid plastic can be obtained by using a thin coating of the plastic over a less expensive substrate.

Currently, printed circuits, torroidal cores, rotors and stators, bus bars, wound cores, high-voltage power transformer covers and housings, electric motor housings, electric lawn mower parts, and other electrical parts are being mass produced on automatic lines at various quantities up to 30,000 parts a day.

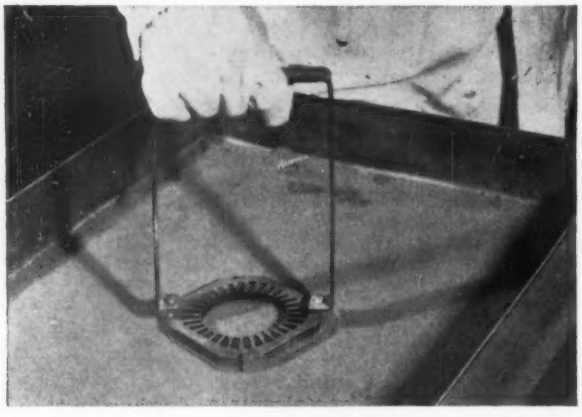

Fig. 1. Typical electrical part being immersed in a fluidized bed.

The fusion bond coatings are applied by dipping a preheated object into a bed of finely divided fluidized plastic powders (Fig. 1).

The thickness of the applied coating depends on the temperature of the part surface, the heat content of the part due to preheating cycles, and the time of immersion in the fluidized bed; see Fig. 2. A controlled uniform thickness of 5 to 50 mils is easily applied in a single dip. Multiple coats, with the resultant handling, baking, and drying times required with solution coating, are not needed.

Good electrical insulation requires uniform thickness of the plastic coatings on sharp edges as well as on major

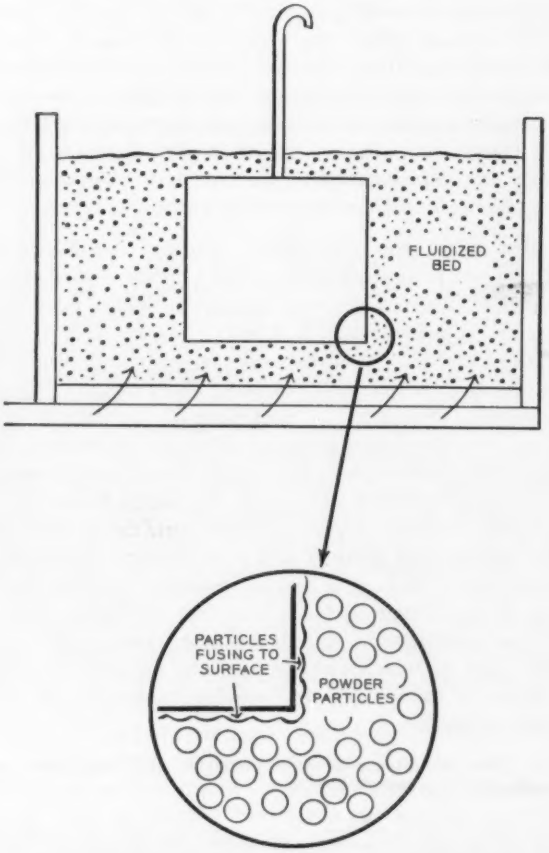

Fig. 2. As individual powder particles contact the heated object, they fuse and adhere to the heated surface. Any area not contacted by a powder particle will remain hot until a particle covers it.

A special article recommended by the Solid Insulation Subcommittee of the AIEE Electrical Insulation Committee.

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The basic fluidized bed process was developed and patented in Germany by Knapsack-Griesheim A. G. of Frankfurt. Polymer's Whirlclad coating system which encompasses the fluidized bed technique is protected by various patents in the United States and elsewhere. Exclusive patent and licensing rights in the United States and Canada are owned by a subsidiary of the Polymer Corporation.

surfaces. Excellent uniformity is a characteristic of the process even over sharp edges, since the dry plastic powder becomes molten only for a very brief period. Tests performed by a midwestern transformer manufacturer indicate the coating uniformity. Coated steel covers were tested for dielectric strength: first, by using a standard electrode, a disk 1 inch in diameter; and second, by using a wet felt blanket over the entire coated surface as the electrode. The wet felt blanket tests the coating at its weakest point wherever it may occur. Test results were as follows:

Material	Standard Electrode, volts/mil	Wet Felt Blanket Electrode,* volts/mil
Cellulosic	1,800	1,100
Epoxy	1,700	1,300
Vinyl	1,200	1,150

* Values obtained on flat surfaces as well as sharp edges.

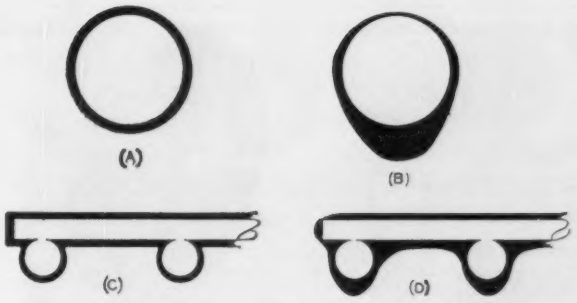


Fig. 3. Whirlclad system uses a coating of uniform thickness that closely follows contour of part, as shown in (A) and (C). Excessive build-up represented by sagging (B) or bridging (D) is virtually eliminated by this technique.

The fluidized bed system with its heat fusion principle eliminates many of the natural disadvantages of solution coatings, as demonstrated by the sketches in Fig. 3. The system produces a coating of uniform thickness that closely follows the contour of the part. Excessive build-up is virtually eliminated by this new technique of applying plastic coatings.

There are six different types of fluidized bed coatings commercially available—cellulosic, vinyl, epoxy, nylon, polyethylene, and chlorinated polyether. The first three are used most frequently in the electrical industry.

CELLULOSIC

ELECTRICALLY, the insulating properties of the cellulosic are good for low-frequency applications. Years of service indicate the cellulosic formulations are completely suitable at distribution transformer operating temperatures. Coatings 15 to 20 mils thick have an average dielectric strength of greater than 1,000 volts per mil. The combination of adequate insulation plus exceptional weathering and impact resistance favors cellulosics over better insulating materials for many applications.

Because cellulosic finishes resist perspiration, greases, and petroleum products, they are particularly useful for electrical products around the home. Light switches, lamp bases, electric motor housings, hand drills, and power mower components are a few of the products coated with cellulosics to withstand these conditions.

On pole-line hardware—high-voltage transformer covers, housings and accessories—the finish is subjected to ultraviolet heat, weathering, abrasion, impact, and corrosive attack. Outdoor weatherability of cellulosic coatings has been verified by exposure to accelerated weathering, salt spray, aging, and abrasion tests. In one instance, the test cycle consisted of alternate exposure to salt water, abrasive dust, ultraviolet, infrared, and weathering. Test results were excellent. Steel panels coated with Corvel (registered trade mark) cellulosic *TC-14* series coatings were exposed for 3,600 hours in an Atlas weatherometer with no apparent effect except a very slight loss of gloss. Salt spray tests conducted on sharp-edged stamped metal plates showed no loss of gloss or color and no evidence of corrosion on the edges after 10,000 hours of exposure.

A major transformer manufacturer sandblasted three test panels with sharp steel grit to obtain some indication of the abrasion-impact resistance of the fluidized bed finishes. One panel was painted, one had a high-quality multiple-coat and bake finish, and the third was coated with cellulosic fusion bond finish. Measurements were taken to establish the time required to sandblast the finish to expose bare metal. Paint abraded through in 5 seconds; the multiple-coat finish, in 8 seconds. After 60 seconds, the test was stopped with no noticeable effect on the fusion bond finish.

VINYL

FLUIDIZED bed vinyl coatings also have good low-frequency dielectric properties and are classified as general purpose insulators. Some specific electrical applications have reported dielectric strengths up to 1,600 to 1,700 volts per mil. The Polymer Corporation recommends using a design value of 800 to 1,000 volts per mil, recognizing that under advantageous conditions the insulation may be better.

Often vinyls and cellulosics can be used for similar applications in the electrical field. Vinyls exhibit superior resistance to chemical attack and can be used at slightly higher temperature than cellulosics. The electrical appliance field is taking advantage of these characteristics and is using vinyl-coated parts extensively in automatic washing machines, dishwashers, refrigerators, and miscellaneous kitchenware.

Many different grades of vinyl are available, from semirigid to highly flexible and rubber-like. Soft grades have increased resiliency and elongation. The harder grades have greater tensile strength and toughness. High impact resistance and resilience are characteristics of all the vinyls.

EPOXY

EPOXY FUSION BOND FINISHES have exceptionally good insulating properties, particularly at elevated tempera-

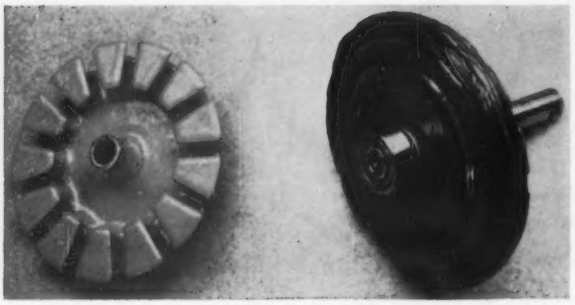


Photo Courtesy Whittaker Controls

Fig. 4. Corvel epoxy powders applied by the Whirlclad system reduced insulation costs on this pancake armature more than 65%.

tures. Various epoxy formulations are available in rigid, semiflexible, and flexible finishes with different combinations of electrical, physical, and chemical properties. Properly applied, they have good impact resistance, at times exceeding 160 inch-pounds. Desirable dielectric characteristics are obtainable anywhere on the surface of the object. Whittaker Controls is insulating pancake-type armatures, see Fig. 4, with heavy epoxy coatings at a 65% savings over the previous fish paper and varnish design.

The following typical short-time dielectric strength values were obtained with epoxy fluidized bed coatings at room temperatures and 50% relative humidity:

Thickness, mils	*Dielectric Strength, volts per mil*
7	2,300
10	1,900
13	1,400
25	1,200

Even after immersion for 24 hours in water at room temperature, the 13- and 25-mil samples showed dielectric strength values of 1,350 and 950 volts per mil, respectively.

Epoxies are often thought of as brittle materials. However, some epoxies properly applied by the fluidized bed process withstand substantial deformation. One disadvantage of the present commercially available epoxy formulations is that they chalk and weather very badly. This chalking often adversely affects the moisture absorption which, in turn, can lower the dielectric constant substantially.

MISCELLANEOUS COATINGS

THE OTHER THREE commercially available coating materials—nylon, polyethylene, and chlorinated polyether—are of considerably less interest to electrical engineers. Although all three materials are fair to good insulating materials, they are specified primarily for other properties.

Nylon's dielectric strength of approximately 700 volts per mil is adequate for some electrical applications where low friction or good wear is also a must. Switch box cover plates, bus bars, and some radar and calculator components have successfully utilized nylon fusion-bond coatings.

Polyethylene coatings combine low water absorption and excellent chemical resistance with good electrical properties including low power factor and dielectric constant and high resistivity and dielectric strength. Polyethylene finishes are used on battery hold-downs, electroplating jigs and hooks, etc.

Chlorinated polyether is a relatively new plastic that is achieving exceptional results in the chemical industry for coating valves, pump housings, pump impellers, piping, etc. Corvel chlorinated polyether coatings have withstood most common plating solutions with no effect. Dielectric strength is about 1,000 volts per mil. Coatings have a low loss factor, but should not be used at high frequencies. Where these electrical properties are required in a highly corrosive environment, chlorinated polyether coatings are recommended.

Table I. Properties of Fluidized Bed Coatings[a]

Properties	Cellulosic	Vinyl	Epoxy
Chemical Resistance			
Exterior Durability	E	VG	F
Salt Spray	E	E	E
Water (salt, fresh)	E	E	VG
Solvents			
Alcohols	F	E	E
Gasoline	G	E	E
Hydrocarbons	G	G	E
Esters, Ketones	P	P	F
Chlorinated	P	P	E
Salts	VG	E	E
Ammonia	P	E	P
Alkalis	F	E	VG
Mineral Acids			
Dilute[b]	G	E	E
Concentrated[c]	P	G	G
Oxidizing Acids			
Dilute[b]	P	E	G
Concentrated[c]	P	G	P
Organic Acids			
Acetic, Formic, etc.	P	F	F
Oleic, Stearic, etc.	F	E	E
Mechanical and Physical Properties			
Abrasion Resistance	VG	G	VG
Flexibility	VG	E	P
Impact Resistance	E	E	G
Max. Service Temp., deg. F.	180	200	350+
Dielectric Strength	G	G	E
Decorative Properties			
Color Range[d]	U	U	L
Color Retention	E	VG	F
Initial Gloss	E	VG	G
Gloss Retention	E	G	P
Relative Cost[e]	1.0	1.0	1.4

[a] These data are intended only as a preliminary selection guide. Final selection should be made after consulting with coating formulator and after suitable testing. Data are based on Corvel fusion bond coating as supplied by Polymer Corp. Key: E=excellent, VG=very good, G=good, F=fair, P=poor

[b] Dilute=10%

[c] Concentrated=over 30%

[d] U=unlimited (any color can be furnished); L=slightly limited (some difficulty in forming whites and pastels). Consult formulator for exact colors obtainable.

[e] For materials only. All costs are relative to vinyl which is assumed to have a value of 1.00. Thus, epoxy materials cost 1.4 times as much as an equal weight of vinyl materials.

COSTS

SUBSTANTIAL SAVINGS are possible because of short cycle times. The total cycle time for a typical coated part (Fig. 5), is less than 20 minutes, as contrasted to as much as several hours in many conventional coating processes. Immediately after cooling, the parts can be

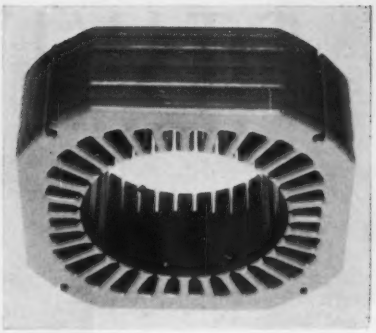


Fig. 5. Laminated stator. Cycle time for coating was less than 20 minutes.

Table II. Costs of Fluidized Bed Coatings

	Vinyl, cents per part	Epoxy, cents per part
Degreasing and priming (5 minutes)	0.1	0.05
Labor	2.4	1.20
Material		
Coating	6.1	1.80
Material loss including rejects	0.3	0.09
TOTALS	8.9	3.14

These cost figures are based on typical electrical parts which would be coated by vinyl or epoxy. (*Note: the two parts are distinctly different.*) A typical vinyl coated part such as bus bars or metal stampings would have a coated area of approximately 1 square foot. Epoxy coated parts such as rotors and stators would have an approximate coated area of ¼ square foot. The labor rates are based on 1,000 parts per hour for vinyl coating and 2,000 parts per hour for epoxy coatings. Powder costs for both are based on 5,000-pound quantity prices.

packaged, shipped or used. No additional drying, baking, or setting time is needed. This is particularly important where coated electrical parts are integrated into assembly lines.

Obviously, it is not proper to compare cost without also comparing quality. General finishing industry standards set 5 mils as minimum for adequate protection with organic coatings. In addition, a quality coating must also provide a continuous film of uniform thickness over the entire part. The minimum thickness for a continuous coating varies with the process. The minimum thickness for a continuous fusion bond coating is 5 mils; for plastisol, 10 mils; and for some solution coatings, 0.1 mil. Organic finishes range from a thin single coat applied by a man with a paint brush to elaborate multicoat, multibake processes that may entail anywhere from 5 to 15 dipping and spraying operations.

Fluidized bed coatings are not directly competitive in cost with a single-coat solution finish. However, when two coats of solution finish are required, the fusion bond coatings are competitive, and they are generally more economical than three or more coats.

For exceptionally close tolerance electrical work, fusion bond coatings can be machined. One electronics manufacturer is coating radar components with nylon and subsequently machining the nylon coating to varying thicknesses. In this way, precise spacing can be obtained between moving parts.

As with any new development, improvements in techniques, materials, and applications are being made constantly. New resins, as well as variations of the currently available materials, are being developed for use in the process. As these new coatings are developed, offering harder or softer surfaces, greater resilience, superior electrical properties, greater color variety, and so forth, the fluidized bed process will become an even more valuable tool to the electrical engineer.

Table III. Typical Cycle

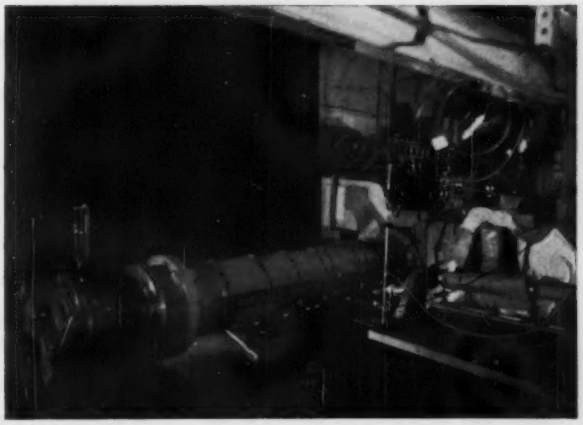
	Vinyl	Epoxy
Preheat temperature, degrees F.	575	325
Preheat time, minutes	5 to 10	15
Dipping time, seconds	5	3 to 5
Postheat or curing time,* minutes	1 to 2	20 or 30
Postheat or curing temperature,* degrees F.	475	425 or 400

* Postheat cycle for vinyl is merely a surface-smoothing cycle. Epoxy must have a curing cycle during which it undergoes a chemical change.

Magnetic Annular Shock Tube

A 5-foot magnetic annular shock tube (MAST) has been developed by Avco-Everett Research Laboratory, Everett, Mass., for advanced magnetohydrodynamic (MHD) studies. The MAST will be used to investigate the basic principles of MHD—the interaction of a high-temperature highly ionized gas, or "plasma," with a magnetic field. Emphasis will be on the behavior of the magnetic field in a plasma, the radiation emitted by the plasma, and the electrical conductivity of the plasma.

The studies will also play an important role in the application of MHD to space flight and power generation and many new areas of application. Earlier experiments in a 30-inch MAST showed the existence of interplanetary shock waves.



INSTITUTE ACTIVITIES

Dr. A. B. DuMont, Television Pioneer, Selected for Honorary Membership in AIEE

DR. A. B. DUMONT, industrialist and television pioneer, has been named an honorary member of AIEE, the highest honor awarded by the Institute.

A certificate of honorary membership will be presented to Dr. DuMont on June 18 at the opening session of the AIEE Summer General Meeting at Cornell University.

Dr. DuMont who lives at Cedar Grove, N. J., began his electronics career of half a century when he built a wireless set in 1912.

Dr. DuMont is the 48th eminent person to be made an honorary member of the Institute since it was organized in 1884. Others so honored include Norvin Green, first president of AIEE; Lord Kelvin, the British scientist; Cyrus Field, father of the transatlantic cable; Guglielmo Marconi; Ferdinand Foch; Herbert Hoover; Thomas A. Edison; Elihu Thomson, one of the founders of General Electric Company; Vannevar Bush, and Edwin H. Armstrong, inventor of frequency-modulation radio.

DuMont Laboratories Founded

Dr. DuMont founded the Allen B. DuMont Laboratories, Inc., and was chairman of the Board of Directors and general manager, prior to its merger with Fairchild Camera and Instrument Corporation, Syosset, N. Y. He is now group general manager of the Allen B. DuMont Laboratories Division of Fairchild. The Laboratories have been his life work since 1931.

Dr. DuMont was born in Brooklyn, N. Y., on January 29, 1901, and built his first wireless receiver and transmitter when he was 11. At the age of 15, Dr. DuMont secured a wireless operator's license, first class, and during his high school and college years he spent his summers on ocean vessels as a wireless operator. After graduation from Rensselaer Polytechnic Institute with a degree in electrical engineering, he joined Westinghouse Lamp Company. One of the improvements Dr. DuMont instituted made it possible to test 5,000 tubes an hour. He is a recipient of the Westinghouse Achievement Award.

He left Westinghouse to become production vice-president of the DeForest Radio Company, where he was instrumental in the increase of radio tube production, and helped build the first television transmitters for the simultaneous broadcast of sight and sound.

In 1931, Dr. DuMont left DeForest to begin independent development of cathode-ray tubes for television. With an initial investment of $1,000, he set up a laboratory in the garage of his Upper Montclair, N. J., home where he constructed and attempted to market a cathode-ray oscilloscope on a commercial basis. After a long struggle to develop markets for the tubes and instruments, he sold an invention, "The Magic Eye," to the Radio Corporation of America and with the proceeds bought and renovated an old factory in Passaic. In 1933, Dr. DuMont conceived an idea for locating objects by radio waves, but at the request of the U. S. Army Signal Corps, a patent application was withdrawn for security reasons. Later, radar used this technique.

Television Receivers Manufactured

The company's first all-electronic television receivers were manufactured in 1937 and were sold to the public in 1938. At the same time, the company established an experimental television transmitter at its Passaic plant and began regular programming.

World War II interrupted the marketing of television receivers and the development of the industry, and DuMont, together with the entire electronic industry, played its part in providing the armed forces with the electronic instruments necessary for warfare. DuMont employees received the Army–Navy "E" for their performance in making cathode-ray tubes and radar components in tremendous quantities.

With the end of World War II, DuMont converted immediately to peacetime electronic production and was among the first American companies to put postwar television receivers on the market.

The company participated extensively in the National Television Systems Committee, whose recommendations resulted in the establishment in 1941 of present standards for black-and-white television broadcasting and the establishment in 1953 of present compatible color standards.

A. B. DuMont

Dr. DuMont is a Fellow of the Institute of Radio Engineers, the Society of Motion Picture and Television Engineers, and the Television Society of England. He was the first president of the Television Broadcaster's Association and is vice-president of the Board of Trustees of Rensselaer Polytechnic Institute. He has been awarded honorary doctorate degrees from Rensselaer, Brooklyn Polytechnic Institute, Fairleigh Dickinson University, New York University, and Montclair State College.

Among his honors and awards are the American Television Broadcasters' Association Award, the Marconi Memorial Medal of Achievement, the Gold Medal of the American Association for the Advancement of Science, the American Schools and Colleges "Horatio Alger Award," and the Boston Jubilee Award for Industrial Statesmanship. He was named Chevalier of the National Order of the French Legion of Honor and Engineer of the Year, New Jersey Society of Professional Engineers.

Dr. DuMont is a member of Sigma Xi, the American Rocket Society, Sigma Delta Chi, the Radio Pioneers, the Explorers Club, the Radio and Television Executives Society, the Veteran Wireless Operators Association, and the Society of Television Pioneers.

Lamme Award To Be Presented for 1960 to Dr. J. G. Trump, MIT Professor

THE Lamme Medal Committee, AIEE, has selected Dr. J. G. Trump (AM '31, M '48, F '59), High Voltage Research Laboratory, Massachusetts Institute of Technology (MIT), for the 1960 Lamme Award. The presentation of the award will take place at the AIEE Summer General Meeting on June 19, 1961, in Ithaca, N. Y.

The following citation will accompany the award:

"For meritorious achievements in the design of particle accelerators and X-ray generators; more specifically for invention and design related both to multielectrode acceleration tubes and to Van de Graaff generators; and also for exceptional contributions which led to applications in treatment of malignant disease."

Known for X-Ray Design

A professor in the Department of Electrical Engineering at MIT, Dr. Trump is widely known for his design of high-

voltage X-ray and electron sources based on the principle of the original Van de Graaff electrostatic generator. These X-ray machines are extremely effective in medical research and in the treatment of malignant diseases.

Dr. Trump is a native of New York City and received his bachelor's degree in electrical engineering from the Polytechnic Institute of Brooklyn in 1929. He earned the M.A. degree at Columbia University in 1931 and a doctorate in science from MIT in 1933.

For a time, he worked with the General Electric Company in the transformer design section, and he later became an instructor in electrical engineering at the Polytechnic Institute of Brooklyn. He was a research associate at the Institute during 1933-36, was appointed assistant professor in 1936, was promoted to associate professor in 1941, and to full professor in 1952.

In his early years at MIT, Dr. Trump was engaged with Prof. R. J. Van de Graaff in the study of the voltage insulation properties of high vacuum and compressed gases, and in the application of the Van de Graaff electrostatic generator to the production of megavolt X rays for use in medicine. He designed one of the first million volt X-ray generators used in cancer therapy for the Collis P. Huntington Memorial Hospital in Boston, Mass. This machine, first used clinically in the Spring of 1937, was followed in 1940 by a more compact 1.25 million volt X-ray unit, which remained in use for radiation therapy at the Massachusetts General Hospital for the next 15 years.

War Service Mentioned

During World War II, Dr. Trump devoted his entire attention to vital war projects. In 1940, he became technical aide to Dr. K. T. Compton, then president of MIT and chairman of the radar division of the newly created National Defense Research Committee. In 1942, he was made the secretary of the Microwave Committee of the National Defense Research Committee and later was appointed the director of the British branch of the Radiation Laboratory, where he served from February 1944 until the end of the European phase of the war. During this period, he was a member of General C. A. Spaatz' Advisory Specialist Group on Radar. Then he served in MIT's Radiation Laboratory as the assistant director in charge of Field Service. In 1947, the King of England bestowed His Majesty's Medal on Dr. Trump for his assistance to the U. S. Air Force and his co-operation with Britain in the field of radar. Dr. Trump was awarded the President's Certificate of Merit in 1948 for "outstanding services to his country."

In the postwar period, Dr. Trump and his associates resumed their studies of high-voltage phenomena, the acceleration of electrons to high energies, and the interaction of such radiations with living and nonliving matter. In co-operation with the medical staff of the Lahey Clinic in Boston, an investigation was begun in 1949 on the use of 2 million volt X rays in the therapy of malignant disease. More recently, this group has studied the direct treatment of superficial lesions with high-energy electrons. This and other work has received the support of the Godfrey M. Hyams Trust, the National Institutes of Health, the Damon Runyon Memorial Fund, and the National Science Foundation.

J. G. Trump

Contributed Important Papers

Dr. Trump has contributed numerous important papers to the field of his special interests in electrical engineering and radiology. For many years, he has given an annual course in radiation physics, sponsored by the New England Roentgen Ray Society, to residents in radiology in the Boston region. He is a Fellow of the American Physical Society, Sigma Xi, and Tau Beta Pi; an associate member of the American Radium Society and the American Roentgen Ray Society, and a Fellow of the American Academy of Arts and Sciences.

In 1946, Dr. Trump, with Dr. R. J. Van de Graaff and Dr. D. M. Robinson, organized the High Voltage Engineering Corporation of which he is the chairman of the board and technical director. He is also director of Machlett Laboratories, Inc., of Springdale, Conn., leading manufacturers of X-ray and high-frequency power tubes.

Annual Meeting

The Annual Meeting of the AIEE will be held in Ithaca, N. Y., at 2:00 p.m., Monday, June 19, 1961, during the Summer General Meeting.

At this meeting, the annual report of the Board of Directors and the reports of the Tellers Committee on the ballots cast for the election of officers and for the proposed amendments to the AIEE Constitution will be announced. A certificate of Honorary Membership in the Institute will be presented to Allen B. Du Mont (F '43). The Lamme Medal will be awarded to John G. Trump (AM '31, M '48, F '59).

Such other business, if any, as may properly come before the Annual Meeting may be considered.

Signed N. S. Hibshman
Executive Secretary

G. W. Gruver

Fortescue Fellowship Awarded to G. W. Gruver

The Charles LeGeyt Fortescue Fellowship Committee of AIEE has awarded a Fellowship for graduate study in electrical engineering during the academic year 1961-62 to G. W. Gruver.

G. D. Lobingier of Westinghouse Electric Corporation, East Pittsburgh, Pa., is chairman of the committee administering the award for the Institute.

Born June 29, 1935, in Oklahoma City, Okla., Mr. Gruver received the B.S. degree in electrical engineering in 1961 from Oklahoma State University and is now working towards the M.S. degree in electrical engineering at that university.

A member of Eta Kappa Nu, for which he served as recording secretary and vice-president, he received the society's Outstanding Sophomore Award for 1958-59. He has been elected to Who's Who at American Universities and Colleges and has received the Westinghouse Achievement Award Scholarship for the academic year 1960-61. He is a member of Phi Kappa Phi, the Institute of Radio Engineers, and the U. S. Navy Reserve where he has instructed electronics for the last 2½ years.

The Fortescue Fellowship was established in 1939 by the Westinghouse Electric and Manufacturing Company, now Westinghouse Electric Corporation, as a memorial to Charles LeGeyt Fortescue for his contributions to the electric power industry.

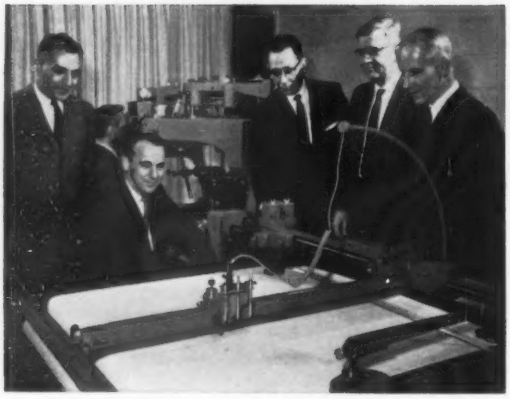
Dr. Fortescue, who was graduated from Queens University, Kingston, Ont., Canada, as the university's first electrical engineer in 1898, received 185 patents on electrical inventions during his 38-year career with Westinghouse.

Systems Engineer Cited for Outstanding Achievement

J. W. Porter (AM '55), systems engineer, BMEWS, Missile and Surface Radar Division, Radio Corporation of America, Moorestown, N. J., has been named recipient of the 1961 David Sarnoff Outstanding Achievement Award in Engineering for development and implementation of the means by which the Ballistic Missile Early Warning System (BMEWS) discriminates between missiles and other space objects.

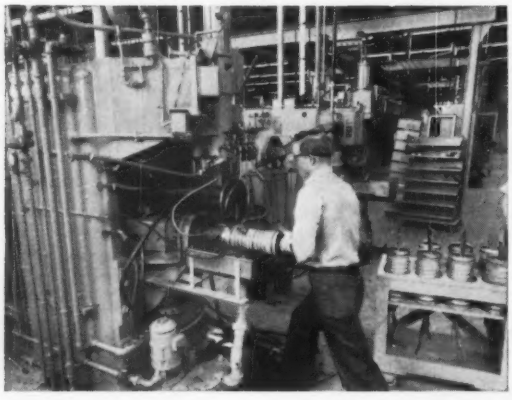
Technical Sessions + Committee Meetings

AIEE Summer



Cornell's High-precision stereo-plotter.

Ionospheric research project.



Westinghouse Transmitting Tube Section.

THIRTY-SEVEN technical sessions are being planned for the AIEE Summer General Meeting to be held June 18-23 at Cornell University, Ithaca, N.Y. The technical sessions are being organized by the technical committees in the six Divisions of the Technical Operations Department.

In the Power and Science and Electronics Divisions, the Power Generation and Nucleonics Committees are pooling their efforts in setting up two joint sessions. Other Power Division sessions are being organized on the subjects of Switchgear, Rotating Machinery, System Engineering, Transmission and Distribution, Insulated Conductors, Power System Communications, Substations, and Transformers.

In the Communication Division, a session on Radio Astronomy is being planned by the Radio Communication Systems Committee. This is one of the major projects at Cornell University. Other sessions in the Communication Division are planned by the Communication Theory and Wire Communication Systems Committees.

The Feedback Control Systems Committee, in the Industry Division, is organizing three sessions. In addition to this we find in this Division sessions on General Industry Applications, Industrial and Commercial Power Systems, a joint session with this latter Committee and the Relays Committee from the Power Division, and three sessions sponsored by the Chemical Industry Committee.

In the Science and Electronics Division, four of the most important sessions are being organized by the Solid State Devices Committee. Other important sessions in this Division are sponsored by the Electrical Insulation, Electrical Techniques in Medicine and Biology, Basic Sciences, Computing Devices, and Semiconductor Rectifiers Committees.

The Instrumentation Division is well represented; the following Committees are organizing sessions for this meeting: Indicating and Integrating Instruments, Telemetering, Recording and Controlling Instrumentation, and Special Instruments and Auxiliary Apparatus.

Among those Committees that do not fall within the six technical Divisions of the Institute, we find sessions sponsored by the Research, Management, New Technical Activities, and Education Committees. The latter Committee has secured seven papers in the technical field of rotating machines which has evolved into the broader field of electromechanical energy conversion.

Housing Arrangements

Confirmation of housing reservations can only

Inspection Trips + + Social Activities = *General Meeting*

be assured if the advance registration card is received by June 7.

Dormitories. Principal housing facilities for the Summer General Meeting are Cornell University Dormitories. Private bath facilities are not available in the dormitories. Elevator service exists for 650 rooms.

Dormitory rates are:

Single Room	$4.00
Double Room (twin beds)	5.00

Since University housing and dining facilities can not be as flexible as those of professional hotels, the Housing and Dining Committees urgently request all members who plan to attend to co-operate in supplying advance registration information. The order of preference for dormitory, motel, or hotel accommodations should be stated by number. Indicate willingness to share a double room. The University Housing Office discourages attendance of very young children since suitable facilities for their proper care are not available in the dormitories.

Motels. There are approximately 200 rooms available in motels in the area. Motels will be assigned on a first-come first-served basis. Approximate rates follow:

Single Room	$ 7.00 and up
Double Room	8.00 and up
Twin Bedroom	9.50 and up
Family units	15.00 and up

(All facilities include bath)

Hotels. A very limited number of hotel rooms are available in downtown Ithaca. The rates are:

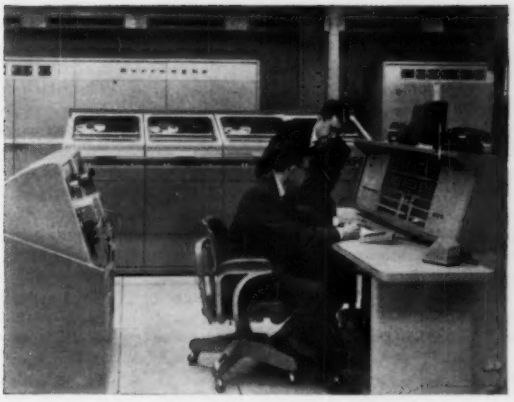
Single (with bath)	$ 7.00 and up
Double (with bath)	10.00 and up

Inspection Trips

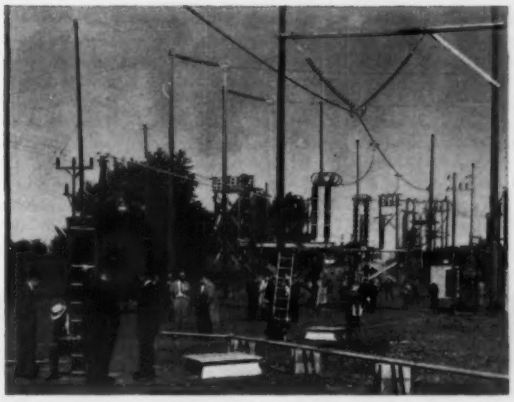
A program of inspection trips follows:

Monday, June 19 (10:00 a. m.) High-Voltage Cable Project. The Association of Edison Illuminating Companies and the Edison Electric Institute are sponsors of a research and test program at Cornell for the study and evaluation of specially designed, extra-high voltage underground power cables. Cable specimens, each of unique design, have been built by four cable manufacturers and installed at the recently dedicated test station at Cornell. No cost for trip.

Tuesday, June 20 (8:00 a. m.) National Homes. The tour of the National Homes Plant at Horseheads, N.Y., has been planned to encompass the major portion of the manufacturing operation so that all may see what goes into making a National Home. After completion of this portion of the guided tour, an inspection of five of their leading design homes will be made available.



Cornell Computing Center.



High-voltage cable research project.

Master engraver at Ithaca Gun Co.

BACK TO THE CAMPUS

Tuesday, June 20 (1:30 p. m.) Cornell Ornithology Laboratory. The Cornell Ornithology Laboratory at Sapsucker Woods is located two miles northeast of the Cornell Campus. This 150-acre woodland, with a 10-acre pond, is a refuge for many kinds of birds, ducks, geese, and herons. Both woodland trails and a comfortable glassed-in area within the laboratory are available for observation and study of these many species. There is no cost for this trip.

Tuesday, June 20 (2:00 p. m.) Cornell Computing Center. The center recently installed a new data processing system in expanded quarters that provide 17 offices for staff and departmental use and three air-conditioned humidity-controlled rooms to house the computer and associated equipment. The new system, known as the Burroughs *220*, is comprised of card, paper tape, and magnetic tape handling equipment, and a data processor with a magnetic core memory. No charge will be made for this trip.

Tuesday, June 20 (4:00 p. m.) High-Voltage Cable Project. This is a repetition of a trip taken Monday at 10:00 a. m.

Wednesday, June 21 (9:30 a. m.) Ithaca Gun Company. Any engineer will marvel at Ithaca Gun's plant on a hillside "far above Cayuga's waters." Visitors may view the master engraver who may take as much as 8 weeks to engrave and inlay a gun, and the 17-ton Rotary Forge, the only one in the American gun industry, which hot forges a gun barrel in a matter of seconds. There will be no cost for this trip.

Wednesday, June 21 (1:00 p. m.) Great Western Wineries. Founded near Hammondsport in the Finger Lakes section of New York in 1860 as the Pleasant Valley Wine Company, Great Western is starting its second century of wine making in this country. The entire process of wine-making may be viewed in the cellars of Great Western. The highlight of the trip is generally considered to be the samples offered at the end of the tour. The approximate cost of this trip is $2.50.

Wednesday, June 21 (1:30 p. m.) General Electric Advanced Electronics Center. The first permanent tenant in the Cornell University Industry Research Park is the applied research and advanced engineering arm of General Electric's light military electronics department. The center is engaged in research and development work in electronic countermeasures, navigation techniques, air-launched missiles and missile guidance, airborne tracking and search radar, sonar, and in the development of other light military equipment necessary to support the tactical and strategic missions of the U.S. Department of Defense. Tours of the center's facilities and presentations and demonstrations of some of the latest developments in military electronics will be given. No charge will be made for this trip.

Wednesday, June 21 (4:00 p. m.) High-Voltage Cable Project. This is a repetition of a trip taken Monday at 10:00 a. m.

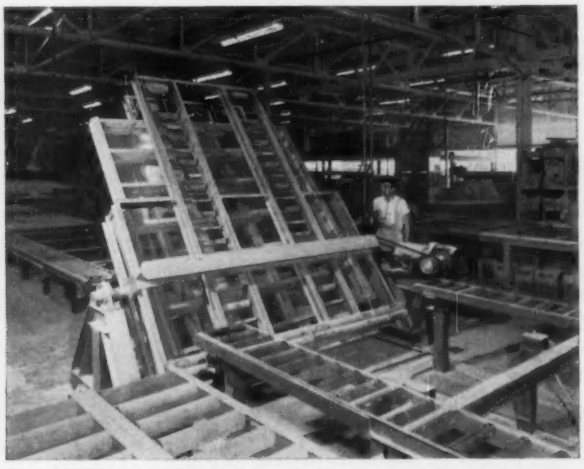
Thursday, June 22 (8:30 a. m.) International Business Machines Corporation (IBM), Endicott, N. Y. The Endicott plant of IBM is the oldest, and at the same time, one of the principal modern plants exclusively manufacturing business machines and electronic computers. The results of modern research have created a new product line composed of electronics, transistors, printed circuits and modular concepts that were not in existence a decade ago. Of particular interest and a high point of the tour is the component assembly and test line of the modular system of printed circuit cards. Later in the tour, the data-processing machines become a reality as the visitor sees the component units flow into the final assembly and test stations. Also to be seen is the manufacturing and assembly of the high speed electromagnetic printers used as output devices of data processing systems. The approximate cost of the trip is $2.

Thursday, June 22 (1:30 p. m.) Westinghouse Tube Plant. The Elmira Plant, one of two in the Electron Tube Division, started operations in 1953. The visit will consist of a tour of the nonclassified manufacturing areas. Operations involving glass blowing, metal sealing to glass, parts making, assembly, exhaust and test of electron tubes may be observed. Exhibits of completed tubes will be stationed along the tour path. Citizenship is not required for this trip. No cameras will be allowed. Adults only will be admitted. The approximate cost of this trip is $2.

Thursday, June 22 (4:00 p. m.) High-Voltage Cable Project. This is a repetition of a trip taken Monday at 10:00 a. m.

Ladies Activities

The ladies' program of entertainment will include morning coffee hours, a session on creative flower arrangements, a card luncheon, an all-day trip to the Corning Glass Works, and trips each



ONE of the principal modern plants exclusively manufacturing business machines and electronic computers, the Endicott, N. Y., plant of the International Business Machines Corporation (*photo at left*) will be toured on June 22 during the AIEE Summer General Meeting. Another inspection tour will be made June 20 through the National Homes Plant at Horseheads, N. Y. (*photo at right*). This guided tour will encompass the major portion of the manufacturing operation, so that all may see what goes into making a National Home.

BACK TO THE CAMPUS

day to the Cornell Ornithology Laboratory.

Ladies headquarters will be at the Elmhirst Room in Willard Straight Hall. The room may be used to meet your friends, plan the days, or for an informal game of cards.

No special program has been planned for teen-agers, but there will be ample facilities for outdoor sports and for family picnicking.

For parents of young children, a list of recommended "sitters" will be available at headquarters for making individual arrangements.

Adequate medical care for all will be provided.

A tentative calendar of ladies' special events follows:

Sunday, June 18

4:00 p.m. Informal Tea

Monday, June 19

9:00 a.m. Coffee Hour

3:00 p.m. Tea and Exhibit of Art and Craft

Wives of area engineers will be in charge.

8:00 p.m. Ornithology Talk

Dr. A. A. Allen, ornithologist and professor emeritus at Cornell University, will have a movie film to illustrate the photographic and sound recording techniques he has used to unravel some of the mysteries of bird behavior. No charge will be made for tickets.

8:00 p.m. Informal Cabaret

Tuesday, June 20

9:00 a.m. Coffee Hour

9:30 a.m. Picnic Trip

Ladies will travel by bus to Enfield Glen and Robert E. Treman State Park. A box lunch, each $1.50, will be held in historic Old Mill. The program also calls for short walks, a 3-mile hike to lower falls, and swimming.

10:30 a.m. Ladies Auxiliary Meeting

8:00 p.m. Informal Cabaret

Wednesday, June 21

9:00 a.m. Coffee Hour

10:30 a.m. Flower Creations

Flower arrangements inspired by music and the dance will be demonstrated by a past and a future director of the Garden Clubs of New York State.

12:30 p.m. Luncheon and Cards

A charge of $3 will be made.

Evening. Chicken Barbeque

Tickets will be priced at about $2.25.

8:00 p.m. Informal Cabaret

Thursday, June 22

8:00 a.m. Coffee Hour

8:00 a.m. Trip to Corning Glass Center

This will include a lecture on the history of glass, tours of the museum, a film "Glass and You," luncheon at a cost of $2.50 per person, and a tour of the Science Hall and the Steuben Factory. Souvenirs, favors, and door prizes will be presented at the luncheon. The bus trip will cost $2. This trip will be limited to 150 guests.

8:00 p.m. Informal Cabaret

Friday, June 23

9:00 a.m. Coffee Hour

Sports

Cornell University has numerous athletic facilities that will be opened for members, guests, and their families. A listing of the sports programs is presented as follows:

Golf. A special tournament has been arranged for both men and women guests on the Cornell University 18-hole championship course. This course is open to all

Tentative Schedule of Events

June 18, Sunday
- Registration Begins, 2:30 p.m.
- Informal Tea, 4:00 to 6:00 p.m.

June 19, Monday
- Ladies Coffee Hour, 9:00 to 10:30 a.m.
- Technical Sessions, 10:00 a.m.
- High-Voltage Cable Project Trip, 10:00 a.m. to 12:00 noon
- Annual Meeting, 2:00 p.m.
- Ladies Tea, Arts and Craft Exhibit, 3:00 to 5:00 p.m.
- Ornithology Lecture, 8:00 p.m.
- Informal Cabaret, 8:00 to 12:00 p.m.

June 20, Tuesday
- National Homes and Corning Apparatus Trip, 8:00 a.m. to 1:00 p.m.
- Technical Sessions, 9:00 a.m.
- Ladies Coffee Hour, 9:00 to 10:30 a.m.
- Ladies Enfield Trip, 9:45 a.m. to 3:00 p.m.
- Ladies Auxiliary Meeting, 10:30 a.m.
- Corning Glass Center Trip, 1:00 to 6:00 p.m.
- Ornithology Lab Trip, 1:30 p.m.
- Cornell Computing Center, 2:00 p.m.
- Technical Sessions, 2:00 p.m.
- High-Voltage Cable Project, 4:00 to 5:00 p.m.
- Informal Cabaret, 8:00 to 12:00 p.m.

June 21, Wednesday
- Technical Sessions, 9:00 a.m.
- Ladies Coffee Hour, 9:00 to 10:30 a.m.
- Ithaca Gun Trip, 9:30 to 11:00 a.m.
- Creative Flower Arrangements, 10:30 a.m.
- Ladies Card Luncheon, 12:30 to 4:00 p.m.
- Great Western Wineries Trip, 1:00 to 6:00 p.m.
- General Electric Trip, 1:30 p.m. and 3:00 p.m.
- Ornithology Lab Trip, 1:30 p.m. and 2:30 p.m.
- Technical Sessions, 2:00 p.m.
- High-Voltage Cable Project Trip, 4:00 p.m. to 5:00 p.m.
- Chicken Barbecue, 6:00 to 8:00 p.m.
- Informal Cabaret, 8:00 to 12:00 p.m.

June 22, Thursday
- Ladies Coffee Hour, 8:00 to 10:30 a.m.
- IBM Trip, 8:30 a.m. to 1:00 p.m.
- Ladies Corning Glass Center Trip, 8:30 a.m. to 6:00 p.m.
- Technical Sessions, 9:00 a.m.
- Westinghouse Trip, 1:30 p.m. to 5:30 p.m.
- Ornithology Lab Trip, 1:30 p.m. and 2:30 p.m.
- Technical Sessions, 2:00 p.m.
- Cornell Computing Center, 2:00 p.m.
- High-Voltage Cable Project Trip, 4:00 to 5:00 p.m.
- Informal Cabaret, 8:00 to 12:00 p.m.

June 23, Friday
- Technical Sessions, 9:00 a.m.
- Ladies Coffee Hour, 9:00 to 10:30 a.m.
- Technical Sessions, 2:00 p.m.

BACK TO THE CAMPUS

Summer Meeting guests. Green fees are $1.50 on weekdays and $2.00 on Saturday and Sunday.

Tennis. Numerous tennis courts of both clay and hard-surface construction are located throughout the Cornell campus. Many courts are within a short distance of the convention housing facilities. The courts are available at no charge on a first-come, first-served basis.

Swimming. Indoor swimming is available at Teagle Hall. A fee of 50¢ will be charged for use of lockers and towels. Outdoor swimming is available at Beebe Lake. Admission is 20¢.

Miscellaneous. A game room is located in Willard Straight Hall. Billiard and table tennis facilities are available at no cost. Many other facilities such as fishing, golfing, bowling, swimming, and water sports are available in the Ithaca area for convention guests and their families.

Transportation to Ithaca

Via Air. Mohawk Airlines provides transportation from the principal cities of New York, Boston, Rochester, Cleveland, Detroit, and Pittsburgh. Pittsburgh service will begin approximately April 15.

Via Railroad. Since Ithaca has no railroad service, those traveling by rail may make bus connections to Ithaca in Syracuse, Binghamton, or Owego. Syracuse is served by the New York Central Railroad, with Greyhound Bus connections to Ithaca, and both the Erie Railroad and the Delaware, Lackawanna, and Western Railroad serve Binghamton and Owego with connections to Ithaca by way of the Trailways Bus Line.

Via Bus. The Greyhound Bus Lines provide transportation to Ithaca from the principal cities of New York, Buffalo, and Boston.

Via Automobile. Routes for those traveling by automobile are recommended as follows:

From the West: New York State Thruway to the Geneva Interchange (No. 42) and N.Y. State 96 to Ithaca.

From the East: New York State Thruway to the Canastota Interchange (No. 34) and N.Y. State 5 to Chittenango, N.Y., State 13 to Cazenovia, U.S. 20 to U.S. 11, U.S. 11 to Cortland, N.Y., State 13 to Ithaca.

From the South: U.S. 220 north to Waverly, N.Y., and N.Y. State 34 to Ithaca or N.Y. State 17 northwest to Owego and N.Y. State 96 to Ithaca.

Registration

Upon arrival, members should register at the registration desk located in the Memorial Room of Willard Straight Hall. The desk will be open at 2:30 p.m. on Sunday and at 8:30 a.m. on Monday through Friday. A housing desk, also in the Memorial Room, will remain open until 10 p.m. every day.

Registration will be much simpler and

quicker if those attending return their advance registration cards. In addition, the information on these cards can be of assistance to the local committee in planning the various inspection trips and social activities.

The registration fees, which are payable on arrival, are $6 for members, $10 for nonmembers, and $2 for ladies. Student members are not charged a registration fee.

The mail address for the Summer Meeting will be: AIEE Headquarters, Willard Straight Hall, Cornell University, Ithaca, N.Y.

Committee Named

The 1961 Summer General Meeting Committee includes the following: W. H. Erickson, general chairman; C. J. Fitch, vice-chairman; R. E. Osborn, treasurer; J. P. Peterson, Finance Committee chairman; M. G. Malti, Program Committee chairman; S. Linke, Housing Committee chairman; N. M. Vrana, Special Events Committee chairman; C. L. Cottrell, Properties Committee chairman; H. G. Smith, Dining Committee chairman; D. Purdy, Publicity Committee chairman; N. H. Bryant, Registration Committee chairman; J. L. Rosson, Sports Committee chairman; P. D. Ankrum, Transportation Committee chairman; Mrs. M. G. Malti and Mrs. C. L. Cottrell, Ladies Committee co-chairmen.

Fox Valley Subsection Meets

John T. Tyner

ATTENDING the March 1 meeting of the newly formed Fox Valley Subsection, AIEE, were: (*seated, left to right*) G. W. Austin, Subsection chairman, and R. A. Otto, semiconductor sales engineer of Westinghouse Electric Company, speaker for the evening program; (*standing, left to right*) D. W. Russell, arrangements chairman; J. R. Lies, membership chairman; W. G. Quist, secretary; W. T. Larner, Chicago Section chairman; E. G. Enabnit, Jr., publicity chairman, and A. H. Pittaway, program chairman. The meeting was held at the Toll Gate Inn in North Aurora, Ill.

AIEE Future Meetings

Joint Rural Electrification and Appliance Conference*
Kentucky Hotel
Louisville, Ky.
May 1-3, 1961

AIEE-IRE-EIA-WCEMA Electronic Components Conference*
Jack Tar Hotel
San Francisco, Calif.
May 2-4, 1961

Spring Textile Conference*
Heart of Atlanta Motel
Atlanta, Ga.
May 4-5, 1961

AIEE-IRE-U of Ill. Midwest Symposium on Circuit Theory*
University of Illinois
Urbana, Ill.
May 8-9, 1961

AIEE-IRE-ACM Western Joint Computer Conference*
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961

Packaging Industry Conference*
New Orleans House
Swampscott, Mass.
May 15-16, 1961

North Eastern District Meeting*
Statler Hotel
Hartford, Conn.
May 17-19, 1961

AIEE-IRE Globe-Communication V Conference**
Sherman Hotel
Chicago, Ill.
May 22-24, 1961

AIEE-IRE-ISA-IAS-ARS National Telemetering Conference**
Sheraton Towers
Chicago, Ill.
May 22-24, 1961

Induction Motor—Computer Conference**
Engineers Club of Dayton
Dayton, Ohio
May 23, 1961

Railroad Computer and Automation Conference*
Engineering Societies Building and Pick-Carter Hotel
Cleveland, Ohio
June 6-7, 1961

Summer General Meeting*
Cornell University
Ithaca, N. Y.
June 18-23, 1961

Pulp and Paper Conference*
University of Western Michigan
Kalamazoo, Mich.
June 21-23, 1961

Aero-Space Transportation Conference*
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961

NOTICE TO AUTHORS

Strict compliance with the "Author's Guide" will save you time, delays, and unnecessary correspondence. For a copy, write to E. C. Day, 33 West 39 St., New York 18, N.Y.

AIEE-AIChE-ASME-IRE-ISA Joint Automatic Control Conference*
University of Colorado
Boulder, Colo.
June 28-30, 1961

JECM&B-IFME International Conference on Medical Electronics
Waldorf-Astoria Hotel
New York, N. Y.
July 16-21, 1961
(Final date for †TP—closed, ‡CP Syn.—May 4, CPMs—May 15)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-IRE-ISA Joint Nuclear Instrumentation Conference
North Carolina State College
Raleigh, N. C.
September 6-8, 1961
(Final date for †TP—June 8, ‡CP Syn.—June 23, CPMs—July 3)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Petroleum Industry Conference
Jung Hotel
New Orleans, La.
September 17-20, 1961
(Final date for †TP—June 19, ‡CP Syn.—July 5, CPMs—July 14)

AIEE-IRE Industrial Electronics Conference
Bradford Hotel
Boston, Mass.
September 20-21, 1961
(Final date for †TP—June 22, ‡CP Syn.—July 7, CPMs—July 17)

AIEE-ASME National Power Conference
St. Francis Hotel
San Francisco, Calif.
September 24-27, 1961
(Final date for †TP—June 26, ‡CP Syn.—July 11, CPMs—July 21)

AIEE-IRE-EIA-SMPTE National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 9-11, 1961
(Final date for †TP—July 11, ‡CP Syn.—July 26, CPMs—Aug. 4)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

AIEE-IRE-ACM Eastern Joint Computer Conference
Sheraton-Park Hotel
Washington, D. C.
December 10-14, 1961
(Final date for †TP—Sept. 11, ‡CP Syn.—Sept. 26, CPMs—Oct. 6)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

South Central District Meeting
Hotel Peabody
Memphis, Tenn.
April 4-6, 1962
(Final date for †TP—Jan. 4, DPMs —Jan. 29)

Great Lakes District Meeting
Hotel Van Orman
Fort Wayne, Ind.
April 18-20, 1962
(Final date for †TP—Jan. 18, DPMs —Feb. 9)

South West District Meeting
Hotel Chase
St. Louis, Mo.
April 30-May 2, 1962
(Final date for †TP—Jan. 30, DPMs —Feb. 23)

Middle Eastern District Meeting
Hotel DuPont
Wilmington, Del.
May 7-9, 1962
(Final date for †TP—Feb. 6, DPMs —Mar. 2)

North Eastern District Meeting
Hotel Statler
Boston, Mass.
May 9-11, 1962
(Final date for †TP—Feb. 8, DPMs —Mar. 5)

*Final date for submitting papers—closed
**Planned to coincide

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Digital Computers in Motor Analysis Is Topic

Digital Computers in Motor Analysis is the subject for the Induction Motor-Computer Conference, to be held May 23 in Dayton, Ohio.

Papers will discuss the design methods and procedures used by several motor manufacturers to predict by digital computers the performance characteristics of a specific 1/3-hp induction motor. The predictions then are checked against the actual results obtained from testing a motor built for the study.

All activities, including registration, lunch, and programs, will be held at the Dayton Engineers' Club, not the Biltmore Hotel as originally announced. However, room accommodations will be available at the Dayton Biltmore Hotel.

Advance registration will be held Monday, May 22, at 7:00 p.m.

The tentative program follows:

Tuesday, May 23

8:30 a.m. Registration

9:30 a.m. Welcome

C. E. Huggins, Delco Products, Dayton Section chairman

9:45 a.m. Morning Session

Introduction: R. W. Leland, Delco Products
Monitor: L. C. Schaefer, Century Elec. Co.

The Design of Single-Phase Induction Motors Using a Digital Computer. *L. W. Buchanan, T. F. Winters,* Westinghouse Elec. Corp.

Single-Phase Motor Design Analysis by Digital Computer. *Jay Vogelsong, Cyril Veinott,* Reliance Elec. Mfg. Co.

A Computer Procedure for Single-Phase Induction Motor Calculation and Design. *K. F. Waldschmidt,* A. O. Smith Corp.

Computation of AIEE Sample Motor. *F. W. Suhr,* General Elec. Co.

12:00 noon Lunch

1:30 p.m. Afternoon Session

Introduction: R. W. Leland, Delco Products
Monitor: P. H. Trickey, Wright Machinery Co.

Motor Design Calculations Using the IBM *650. D. E. Benedict,* Delco Products

Capacitor Start Induction Motor Design and Analysis by Computer. *A. E. Hartman,* Robbins & Myers

Summary Report of Calculations vs. Tests. *George Mueller,* Robbins & Myers

Discussion

The conference chairman is R. W. Leland; conference secretary, B. J. Pleiss, and conference treasurer, Rufus Hawk, all of General Motors Corporation. A. E. Hartman, Robbins & Myers, Inc., is in charge of the technical program; J. M. Rogers, Delco Products, in charge of arrangements, and Russ Shoup, Insulation Manufacturers Corporation, in charge of publicity. Advisors to the conference are William Dynes, WPAFB, and I. M. Levy, Delco Products.

Progress of Institute Technical Groups Program

AIEE MEMBERS received their first published information about Institute Technical Groups by mail and through *Electrical Engineering* in January. Within 2 months, word had been received from 1,225 members indicating interest in the formation of one or more ITG's. Information deduced from these responses is believed to be based on a valid sampling of the entire membership, since the pattern did not change as more responses were received.

To satisfy inquiries about the specific distribution of ITG interests disclosed, and to enable Technical Committee personnel to compare relative interests with those revealed by the all-member questionnaire of 1960, a tabulation by Technical Committees and Divisions is included in this article. The total of ITG elections exceeds the number of members replying because of multiple elections. Two members expressed a wish to join all Groups that might be founded; they were omitted in the table.

For those members who may not have sent in post cards or coupons but who now wish to do so, a tear-out coupon will be found in this article, to be mailed to AIEE Headquarters, 33 W. 39th St., New York 18, N. Y.

From the tabulation it is evident that several Technical Committees already have large enough numbers of elections (50 or more, but less than 300) so that a tentative ITG associated with each is virtually "in existence." However, additional initiative is required, as outlined below, before the first tentative ITG will actually have been formed. Elections by other interested members who have not yet been heard from can easily bring the number of elections up to the threshold figure of 300 required before the subsequent establishment of a permanent ITG and the sending out of bills for membership dues.

There may be some in the Institute who find that the unaided rate of growth so far in the number of elections in an area of particular interest is unsatisfactorily slow. For these members Chairman P. K. McElroy of the ITG Coordinating Committee offers suggestions about ways in which the securing of the minimum of 300 elections may be speeded up:

1. Any Technical Committee Chairman, or members of the Committee itself, may take the initiative to develop interest. Many avenues are open. Members of the Technical Committee and its Subcommittees are likely candidates, for they have already evidenced their interest in the field by working in it. Direct solicitation of members whose names were developed by the interest questionnaire may be undertaken with the help of Headquarters.

2. Interest areas in which Special Technical Conferences have been held are "naturals" for development. A number of people from past and present committees have shown active interest; and the mailing lists carefully developed for Special Technical Conference purposes represent a selected clientele ready-made for ITG cultivation.

3. A Section might decide that it would like to take the initiative in getting an Institute-wide ITG established. It is easiest to conceive of this in the case of a Section in a city which is a center for a particular segment of industry, or which contains a group of industries bound together by a common technical area of interest.

4. A most significant suggestion is that some really enthusiastic member who is not even on a Technical Committee act as a spark plug. This is the way in which

I would like to be a member of an ITG sponsored by the Committee on_____

_____

(For names, see accompanying tabular list of Committees.)

I propose an ITG to be called_____

_____

to cover technical matters as follows:_____

_____

_____

_____

Signed_____

Address_____

_____

similar groups have been founded in other technical societies.

Mr. McElroy states that in future ITG organizing there will be found "no real substitute for enthusiasm, not even a position of authority. If we really believe that in democratic causes each man's vote is important, how much more important is his voice when it is raised to further a cause?"

Among the ITG responses, which came in on cards, tear-outs, and in letters, were brickbats as well as bouquets, all of them thoughtfully and constructively conceived and helpfully offered. The ITG Coordinating Committee is considering them all.

One repeated comment was that the formation of ITG's represents wasteful competition with the Institute of Radio Engineers (IRE) Professional Groups, and could even undermine present efforts toward AIEE-IRE co-operation. This was a point to which members of the ITG Coordinating Committee gave careful and sympathetic attention before launching the ITG program. They found that the objection oversimplifies the real situation. ITG's in the power and industrial areas of the AIEE structure, for instance, would not duplicate groups in any other societies. Furthermore, some Sections for many years have had Technical Discussion Groups and co-operative lecture courses with IRE in what could be called "competitive" areas.

It is not too much to hope that the ITG system would enhance rather than avoid co-operation with IRE in areas of Special Technical Conferences, or symposiums, where there is common interest. Almost universally, meetings are operated jointly by AIEE and IRE groups on a given subject, such as Computers (EJCC), Measurements (Boulder), Reliability and Quality Control, and Telemetering. Such co-operation is more difficult for AIEE when one of its Technical Committees has to match, in the extent of its co-operation, one of IRE's organized Professional Groups. One could envisage the ITG system as being a forward step toward better relations between AIEE and IRE—a matter of policy now dictated by their respective Boards of Directors.

Thus is the ITG program deliberately going forward. The ITG Coordinating Committee (of the Technical Operations Department) is grateful for the thoughtful reactions so far received from numerous members and will welcome further suggestions and criticisms from them or others. The charge to the Committee is to give the members what they wish, within limits only of reason. Members should make their will known.

AIEE Members' Technical Committee Preferences Expressed in 1960 Survey of Primary and Secondary Interest and Institute Technical Groups

		ITG Returns	Primary Interest	Secondary Interest
1-10	**Communication Division**			
1-1	Broadcasting		135	126
1-2	Communication Switching Systems	22	1,115	413
1-3	Communication Theory	17	695	717
1-4	Data Communication	114	443	1,023
1-5	Radio Communication Systems	31	934	703
1-6	Space Communication Systems	43	—	—
1-7	Telegraph Systems	13	170	206
1-8	Wire Communication Systems	31	917	747
1-9	All Committees	15	101	24
1-10	Subtotal ...	286	8,510	3,959
2-7	**General Applications Division**			
2-1	Aero-Space Transportation	41	1,029	427
2-2	Domestic & Commercial Applications	63	867	438
2-3	Land Transportation	10	402	143
2-4	Marine Transportation	5	283	129
2-5	Production & Application of Light	52	330	326
2-6	All Committees	1	4	7
2-7	Subtotal ...	172	2,915	1,470
3-16	**Industry Division**			
3-1	Chemical Industry	7	316	199
3-2	Electric Heating	12	340	353
3-3	Electric Welding	2	129	89
3-4	Feedback Control Systems	118	1,507	1,113
3-5	General Industry Applications	24	1,668	993
3-6	Industrial & Commercial Power Systems	39	1,440	1,360
3-7	Industrial Control	93	1,821	1,989
3-8	Industrial Power Rectifiers	13	240	182
3-9	Machine Tools Industry	18	—	—
3-10	Metal Industry	4	334	315
3-11	Mining Industry	3	153	102
3-12	Petroleum Industry	9	391	219
3-13	Rubber & Plastic Industries	4	—	—
3-14	Textile Industry	2	—	—
3-15	All Committees	1	39	28
3-16	Subtotal ...	349	8,378	6,942
4-10	**Instrumentation Division**			
4-1	Aero-Space Instrumentation	74	418	581
4-2	Electronic & High-Frequency Instruments	15	299	333
4-3	Fundamental Electrical Standards	16	—	—
4-4	Indicating & Integrating Instruments	23	595	326
4-5	Nuclear Instrumentation	12	189	217
4-6	Recording & Controlling Instrumentation	62	557	813
4-7	Special Instruments & Auxiliary Apparatus	9	479	605
4-8	Telemetering	12	196	434
4-9	All Committees	12	23	24
4-10	Subtotal ...	235	2,756	3,333
5-13	**Power Division**			
5-1	Insulated Conductors	23	802	557
5-2	Power Generation	117	2,527	1,248
5-3	Power System Communications	5	487	468
5-4	Protective Devices	33	687	1,193
5-5	Relays	25	600	589
5-6	Rotating Machinery	38	1,864	1,326
5-7	Substations	12	1,396	2,144
5-8	Switchgear	24	956	1,236
5-9	System Engineering	74	2,111	2,204
5-10	Transformers	11	1,140	904
5-11	Transmission & Distribution	233	3,129	2,488
5-12	All Committees	19	234	151
5-13	Subtotal ...	614	15,933	14,508
6-11	**Science & Electronics Division**			
6-1	Basic Sciences	105	692	768
6-2	Computing Devices	114	1,608	1,555
6-3	Electrical Insulation	20	322	819
6-4	Electrical Techniques in Medicine & Biology	9	129	296
6-5	Electronics	143	2,059	2,363
6-6	Magnetic Amplifiers	28	216	431
6-7	Nucleonics	12	217	420
6-8	Semiconductor Rectifiers	27	179	398
6-9	Solid State Devices	40	374	1,215
6-10	All Committees	3	20	38
6-11	Subtotal ...	501	5,816	8,303
7-10	**Other Committees**			
7-1	New Technical Activities	11	—	—
7-2	Research	2	—	—
7-3	Safety	1	—	—
7-4	Standards	8	—	—
7-5	Applied Automatic Techniques	51	—	—
7-6	Man-Machine Integration	10	—	—
7-7	Nuclear Congress & Nucleonics	14	—	—
7-8	Education	16	—	—
7-9	Management	28	—	—
7-10	Subtotal ...	141	—	—
	Grand Total	2,298	44,308	38,515

Column 1, ITG Returns, includes one tally for each committee named or included in a sphere of ITG interest. Columns 2 and 3 showing primary and secondary technical committee interests of members (1) Include all AIEE members in the United States, Mexico, and Canada (returning their reply card from survey); (2) Exclude AIEE members in all other foreign countries because these members were not surveyed (except perhaps a very few new members from these areas who, in their application blanks, were requested to give this data); (3) Exclude all members in arrears as of February 1, 1961.

Subcommittees Schedule Conference on Domestic Appliances — Rural Electrification

A JOINT CONFERENCE of the Domestic Appliances and Rural Electrification Subcommittees of AIEE will be held May 1-3 at the Kentucky Hotel, Louisville, Ky.

The conference will open Monday morning, May 1, with a joint program, and the two groups will continue to be together at mealtimes. However, separate technical sessions on Rural Electrification and Domestic Appliances will be held concurrently beginning Monday afternoon.

W. H. Dennler, general manager of the General Electric (GE) Major Appliance Division will address the conference after lunch Monday. W. C. Russell, vice-president of Louisville Gas and Electric Company, will welcome participants to Louisville.

Papers at technical sessions for persons interested in rural electrification will relate to power requirements of present equipment, trends in agriculture and growing needs for electric power in rural areas. Subjects covered in domestic appliance sessions will range from "A Method of Calculating Thermal Electricity Requirements" to "Facets of Appliance Noise Control."

Inspection trips will include a visit to General Electric's Appliance Park, a 1,000-acre facility employing 10,000 persons in the manufacture of all GE major appliances.

The tentative conference program follows:

Monday, May 1

9:30 a.m. Joint Technical Session

Rural Electrification—H. T. Smith, chairman; Domestic Appliances—W. F. Kindt, chairman

12:00 noon. Joint Luncheon

Presiding: H. N. McGinnes, chairman, Louisville Section AIEE

Welcome to Louisville. W. Russell, vice-president, Louisville Gas & Elec. Co.

Opening Address. W. H. Dennler, general manager, General Elec. Co., Major Appliance Division

2:00 p.m. Rural Electrification Session

2:00 p.m. Domestic Appliance Session

6:30 p.m. Cocktails and Buffet Dinner

W. H. Dennler

Tuesday, May 2

8:00 a.m. Registration

9:00 a.m. Rural Electrification Session

9:00 a.m. Domestic Appliance Session

9:00 a.m. Ladies Tour to General Electric

12:00 noon. Luncheon

Committee activities. B. F. Parr, chairman, Domestic and Commercial Applications Committee

1:30 p.m. Joint Inspection Trips

6:30 p.m. Cocktails and Buffet Dinner

Wednesday, May 3

8:00 a.m. Registration

9:00 a.m. Rural Electrification Session

12:00 noon. Informal Luncheon

A registration desk at the Kentucky Hotel will be open Sunday evening, April 30, at 6:00 p.m. R. L. Royer, Louisville Gas and Electric Company, P. O. Box 354, Louisville, Ky., is registration chairman.

The conference will be sponsored by the AIEE Domestic and Commercial Applications Committee, B. F. Parr, chairman. Chairmen of the subcommittees are W. F. Kindt, General Electric, Domestic Appliances, and H. T. Smith, Kentucky Rural Electric Co-operative Corporation, Rural Electrification. H. N. McGinnes, Louisville Gas and Electric Co., is chairman of the Louisville Section, AIEE, host to the conference.

A tentative list of the Domestic Appliances technical papers to be presented follows:

Thermostatic Bimetals. *C. Zeigler*, W. M. Chace Co.

Cable Heaters. *C. H. Witsken*, Welcraft Products.

Leakage Currents in Appliance Heaters. *A. F. Boice*, General Elec. Industrial Heating Dept.

Double Insulation. *D. C. Krammes*, Hoover Co.

The Decomposition of Chlorine Bleach in Washing. *L. Loeb*, General Elec. Major Appliance Division

Improving Moisture and Water Resistance Compressor Motor Feed through Terminals. *G. B. Helmen, J. B. Kelley*, Westinghouse Elec. Corp.

Component Reliability. *R. L. Heckman*, General Elec. Appliance Controls Dept.

Heat Pump De-Icing Control. *T. I. Syfert*, Ranco.

Thermal Electrical—A Method of Calculating Thermal Electricity Requirements. *J. A. Pietsch*, General Elec. Major Appliance Division

240 Volt to Ground—Residential Utilization. *R. F. Lawrence*, Westinghouse Elec. Corp.

Temperature Correlation between Customer and Supplier for Disc Thermostats. *E. C. Ballard*, Texas Instruments

Residential Utilization Voltages. *H. E. Campbell*, General Elec., Schenectady

Accoustical Testing of Mufflers for Refrigeration Systems. *J. L. Martin*, Whirlpool Corp.

Facets of Appliance Noise Control. *J. L. Martin, A. F. Martz*, Whirlpool Corp.

Studies on Slime Formation in a Cascade Type Humidifier. *N. G. Roth*, Whirlpool Corp.

Factors Affecting the Design of Reliable Electrical Contacts. *M. Oliver*, AMP

2nd Symposium Held on Magnetohydrodynamics

How plasma reacts in the presence of a magnetic field was the subject of the 2nd Symposium on Engineering Aspects of Magnetohydrodynamics, held March 9-10 at the University of Pennsylvania in Philadelphia, Pa.

The engineering aspects of the subject—that is, how this phenomenon can be used—were of special interest during the symposium.

A plasma, in this sense, is that condition of a material during which it cannot be regarded as being in the solid, liquid, or gas categories. It is sometimes called "the fourth state of matter." This dissociated, or ionized, state of a material occurs in nuclear reactions, in outer space where plasma is the substance of the stars, or in other ultrahigh temperature activities.

The sessions were devoted to "communications and diagnostics" (transmitting and receiving energy through and from plasmas), "flight applications" (propelling or controlling vehicles in space or in the atmosphere), "fusion" (extracting energy through controlled thermonuclear fusion), and "power conversion" (direct extraction of electricity from hot, flowing plasma).

The conference was held under the joint sponsorship of AIEE, the Institute of the Aerospace Sciences, the Institute of Radio Engineers, and the University of Pennsylvania.

Symposium Scheduled on Aero-Space Nuclear Propulsion

An International Symposium on Aero-Space Nuclear Propulsion will be held October 23-26 in Las Vegas, Nev.

This symposium is sponsored by the Professional Group on Nuclear Science of the Institute of Radio Engineers, the Atomic Energy Commission, and the National Aeronautics and Space Administration. The meeting will be unclassified and include among other topics a review of the SNAP, ROVER, PLUTO, and ANP programs.

Dr. G. T. Seaborg, chairman of the U. S. Atomic Energy Commission, will be the speaker at the banquet.

Papers are being requested for presentation at the meeting. The subject matter includes instrumentation, control systems, engine simulation, and engine dynamics aspects of aero-space nuclear propulsion and nuclear auxiliary power fields, as well as radiation and temperature effects on instruments and controls.

A rough draft of each paper and a 500-word abstract should be submitted by July 1, 1961, to P. M. Uthe, University of California, Lawrence Radiation Laboratory, Box 808, Livermore, Calif. The length of each paper should be approximately 25 minutes.

Western Joint Computer Conference Will Take Place May 9-11 in Los Angeles

THE tentative program for the Western Joint Computer Conference, to be held May 9-11 in the Ambassador Hotel, Los Angeles, Calif., provides for the presentation of 70 technical papers during 15 sessions.

T. J. Watson, Jr., president of International Business Machines Corporation, New York, N. Y., will deliver the keynote address at the opening session on Tuesday, May 9. He will be preceded by Dr. W. F. Bauer, Ramo-Wooldridge Division, Thompson Ramo Wooldridge, Inc., chairman of this year's conference, who will give the welcoming address. Morris Rubinoff, University of Pennsylvania, Philadelphia, Pa., and chairman of the National Joint Computer Committee, will make some general remarks. The chairman of the opening session will be K. W. Uncapher, chairman of the Rand Corporation, Santa Monica, Calif., and vice-chairman of the conference.

More than 2,500 persons are expected to attend the conference.

'Extending Man's Intellect'

Discussing the conference theme, "Extending Man's Intellect," Dr. Bauer stated, "Indeed it can be said that man's ultimate goal is not to explore the universe, nor to harness unlimited energy, but to build a device equal to or nearly equal to his own mental powers."

The Ladies' Program on Tuesday morning will feature an invited panel comprising: J. W. Granholm, editor, *Computing News*, Thousand Oaks, Calif.; Vincent van Praag, president, Electro-Logic Corporation, Los Angeles, Calif.; and G. G. Vosatka, western regional manager, Bendix Computer Corporation, Los Angeles, Calif. Miss Phyllis Huggins of Bendix Computer Division, Los Angeles, Calif., is the chairman of the Ladies' Program.

The technical sessions will be on the following topics: digital simulation, microsystem electronics, modeling human mental processes, recent advances in computer circuits, problem solving and learning machines, information retrieval, automata theory and neural models, new hybrid analog-digital techniques, large computer systems, automatic programming, memory devices and components, applied analog techniques, pattern recognition, computers in control, and the "human" side of analog systems.

Luncheon Talk Scheduled

The conference luncheon on Wednesday, May 10, will feature a talk on the "Future Applications of Electronic Intelligence" by Simon Ramo, executive vice-president, Thompson Ramo Wooldridge, Inc. Mr. Bauer will be the master of ceremonies.

Among the $3 million worth of products and equipment to be exhibited will be some significant new developments. A total of 55 firms will display their exhibits in 103 booths.

Sponsors of the conference are: AIEE, the Institute of Radio Engineers, and the Association for Computing Machinery. Fees to members of sponsoring organizations will be $6, to nonmembers $10, and to students $2.

JACC Will Take Place June 28-30 in Boulder, Colo.

The 1961 Joint Automatic Control Conference (JACC) will be held June 28-30 in Boulder, Colo., in order to provide a comprehensive forum for automatic control theory and application.

The Program Committee, chaired by the Massachusetts Institute of Technology's Dr. H. M. Paynter, international leader in automatic control, met in Pittsburgh, Pa., to pursue the chore of molding a comprehensive, cohesive program from the 123 contributed papers. Program committeemen representing AIEE, American Institute of Chemical Engineers (AIChE), American Society of Mechanical Engineers (ASME), Institute of Radio Engineers (IRE), and Instrument Society of America (ISA) worked in rolled-up shirtsleeves through an entire day to develop what unquestionably will be the outstanding automatic control event of the year. ISA is the 1961 sponsor. They sifted the program to 59 of the most pertinent papers.

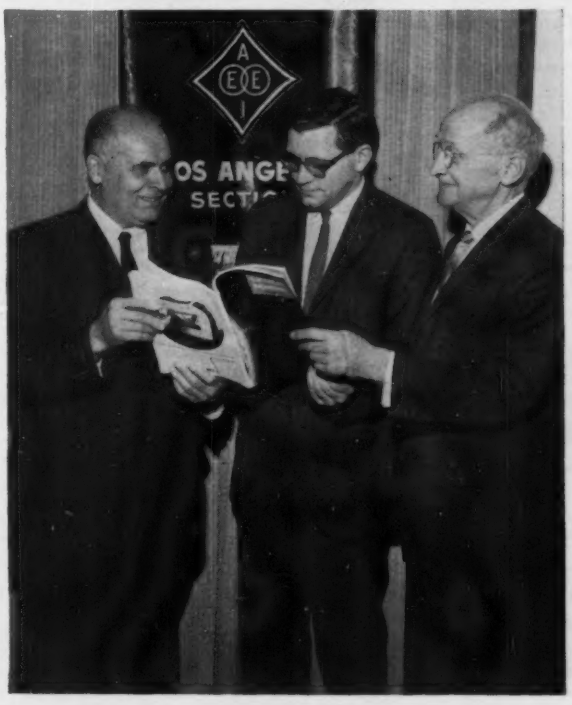
Papers of all five societies have been combined in sessions without regard to Society origin. Following a Plenary Session on Wednesday morning, June 28, the following sessions are scheduled through Friday afternoon: Theory of Optimization, Hydraulic and Pneumatic Control, Economic Parameters in Process Control, Optimum Switching (two sessions), Aerospace Vehicle Control (two sessions), Process Dynamics, Automatic Control Applications, Adaptive Control Systems, Nonlinear Control Systems, Statistical Design Considerations, Special Topics in Control, Process and Control Nonlinearities, and Time Series and Process Identification.

General Conference Chairman, R. K. Adams of Oak Ridge National Laboratories, announced that all JACC registrants will receive a complete bound digest of all papers. The essence of each paper will be presented in 750 words and up to 8 charts and illustrations. Complete papers are being reviewed for inclusion by each Society in their respective *Transactions*.

Advance programs and registration forms will be available from the Meetings Manager, Instrument Society of America, 313 6th Ave., Pittsburgh 22, Pa.

Mr. Adams, general chairman of the 2nd annual JACC, has been a working member of the active Oak Ridge Section of ISA for 10 years. He has been ISA's alternate to the American Automatic Control Council. Dr. Paynter, program chairman of the conference, is associated with the teaching staff of the Massachusetts Institute of Technology.

Los Angeles Section Features Optical Maser



DRAWING upon extensive experience in current optical maser projects, R. J. Collins (*center*) of the Bell Telephone Laboratories presented an illustrated and comprehensive discussion of maser properties at the February 14 dinner meeting of the AIEE Los Angeles Section. Mr. Collins is shown in a pre-dinner discussion of a recent *Electrical Engineering* article with Prof. L. L. Grandi (*left*), vice-president of the Section, and Robert Milmoe (*right*), Section chairman. A million times brighter than the sun, the optical maser is expected some day to provide vast numbers of communications channels as well as other important scientific benefits.

Rothschild

7th Annual Conference Sponsored by Pulp and Paper Industry Subcommittee

THE 7th Annual Conference on Electrical Engineering as applied in the Pulp and Paper Industry will be held June 22-23 at Western Michigan University. An attendance of more than 200 ranking pulp and paper mill electrical engineers and industry associates are expected from various sections of the United States and Canada.

The annual technical conference is sponsored by the AIEE Pulp and Paper Industry Subcommittee. The 1961 conference is being held through the co-operation of the Department of Pulp and Paper Technology of Western Michigan University in Kalamazoo, Mich.

Western Michigan University will provide an academic atmosphere and offer excellent facilities for the conference. The Pulp and Paper Technology Laboratories, completed in 1959, feature a complete paper mill laboratory for student training and industrial research and development. The laboratory is equipped with 24-inch-wide experimental paper and coating machines capable of producing quality sheets at commercial speeds.

The 1961 technical conference includes a timely program featuring some of the aspects of data logging, modern control center practice, boiler control, and improved d-c machine insulations. As in the past, all of those who attend the conference will receive a bound copy of the papers presented.

Kalamazoo is located in south-central Michigan, 50 miles south of Grand Rapids and approximately midway between Chicago and Detroit. The city is served by Lake Central and North Central Airlines and by New York Central and Pennsylvania Railroads.

The tentative technical program follows:

Thursday, June 22

8:30 a.m. Registration

9:30 a.m. Conference Opening

Chairman: J. M. Yarbrough, AIEE Pulp and Paper Subcommittee, Mead Corp.

Conference Chairman: D. B. Gearhart, 7th Annual Technical Conference, General Elec. Co.

Addresses of Welcome:

Dr. G. E. Kohrman, dean of School of Applied Arts and Sciences, Western Mich. Univ.
Dr. J. R. Fanselow, head of Dept. of Pulp & Paper Technology, Western Mich. Univ.

10.00 a.m. Morning Technical Program

Presiding: N. L. Heberer, Champion Paper & Fiber Co.

Paper Making in One Easy Lesson for Electrical Engineers. *Robert Diehm*, Western Mich. Univ.

11:00 a.m. Data Logging Seminar

Chairman: C. A. Fletchinger, International Paper Co.

System Assembly and Components. *W. Mikelson*, General Elec. Co.

Techniques of Data Logging. *R. P. Derrick*, Westinghous Elec. Corp.

Pulp and Paper Mill Data Logging Applications. *L. C. Crowder*. St. Regis Paper Co.

Luncheon

Speaker: Dr. Ward Harrison, pres., Allied Paper Co.

2:15 p.m. Afternoon Technical Program

Presiding: C. L. Eletson, vice-chairman, AIEE Pulp and Paper Industry Subcommittee, Hopper Paper Co.

Boiler Flame-Out Control.

The Application of Instantaneous Trip Circuit Breakers in Motor Control Centers. *W. F. Huette*, Allen-Bradley Co.

5:30 p.m. Social Hour

Sponsored by the manufacturers

7:00 p.m. Banquet

Toastmaster: A. A. Southon, retired chairman of board and director emeritus K.V.P., Sutherland Co.

Speaker: Rice Kello, zone manager, Investors Div. Services

Friday, June 23

Presiding: J. D. Grady, Oxford Paper Co.

9:30 a.m. D-C Motor and Generator Insulation Panel Discussion

Chairman: J. S. Kirkland Rome Kraft Co.
Panel Members: D. E. Bivins, Olin Matheison; P. T. Schuerman, General Elec. Co.; A. G. Posluszny, Westinghouse Elec. Corp.; Walter Stiffler, Reliance Elec. & Engrg. Co.; Henry Murdock, Allis Chalmers Mfg. Co.

Mill tours will be conducted Friday afternoon.

On Wednesday, June 21, a joint luncheon will be held at 12:00 noon for the AIEE Pulp and Paper Industry Subcommittee and the Canadian Pulp and Paper Association.

At 1:30 p.m., the annual business meeting of the AIEE Pulp and Paper Subcommittee will be held at the Student Center Building. At the same time, the business meeting of the Electrical Engineering Committee of the Canadian Pulp and Paper Association will take place at the Student Center Building.

Conference preregistration will begin at 6:00 p.m.

The AIEE Pulp and Paper Industry Subcommittee is headed by the following officers: Chairman—J. M. Yarbrough, Mead Corporation, Chillicothe, Ohio; Vice-Chairman—C. L. Eletson, Hopper Paper Company, Taylorsville, Ill., and Secretary—J. S. Kirkland, Rome Kraft Company, Rome, Ga.

Members of the General Conference Committee are: D. B. Gearhart, chairman, General Electric Company; Dr. John Fanselow, Western Michigan University; D. Leonardilli, Western Michigan University; Miss Katherine Stokes, Western Michigan University; Joseph Freeman, Kalamazoo Chamber of Commerce; Jim Kniffin, Metrol Company; Don Yost, Sutherland Company, and Robert Paul, Consumers Power Company, all of Kalamazoo, Mich.

The Program Review Committee include: Chairman—K. P. Grenfell, Schenectady, N. Y.; S. A. Bobe, Atlanta, Ga.; R. J. Farrell, Cleveland, Ohio; J. D. Grady, Rumford, Me.; N. L. Heberer, Hamilton, Ohio, and E. H. Overby, Savannah, Ga.

R. P. Derrick, Westinghouse Electric Corporation, East Pittsburgh, Pa., is chairman of the Publicity Committee, and C. B. White, Allis-Chalmers Company, Norwood, Ohio, is co-chairman. Russell Strong and A. E. Vickery of Kalamazoo, Mich., are members of the committee.

Symposium To Stress Supplier–User Co-operation

Industrial progress through co-operation and understanding between electronic equipment suppliers and industrial users of such equipment will be stressed at the 1961 Industrial Electronics Symposium. Sponsored jointly by AIEE, the Institute of Radio Engineers' Professional Group on Industrial Electronics, and the Instrument Society of America, the Symposium will be held September 20-21 at the Bradford Hotel, Boston, Mass.

The Symposium will have C. Metcalfe, chairman, Electronic Forum for Industry, London, England, as a luncheon speaker. The Electronic Forum for Industry is a British organization formed in February 1959 to foster a closer liaison between the manufacturers and users of electronic equipment.

A highlight of the meeting will be a session consisting of a panel of electronic experts in various phases of industrial electronics who will answer industrial users' questions. The moderator for the panel discussion will be William Vannah, former chief editor of *Control Engineering*, who is now an associate for advanced engineering of the Foxboro Company, Foxboro, Mass.

Three additional technical sessions are planned. The first one on Measuring Techniques for Industry will have Dr. C. W. Clapp, consulting physicist, instrument department, General Electric Company, as session chairman. Papers to be presented will cover such topics as noncontact measuring techniques, nondestructive fault testing, moisture measurement, and infrared and chromatography techniques.

The second session will deal with Digital and Analog Techniques in Industry and will have F. W. Atkinson of Owens-Corning Fiberglas as chairman. It will cover both analog and digital blending techniques stressing actual case histories, three-mode controllers, and computers.

The final session will cover New Power Conversion Techniques. C. H. Chandler of Gillette Safety Razor Company will be session chairman. Papers in this session will include a novel system for coupling a turbine to a variable-speed drive with silicon-controlled rectifiers, ultrasonic machining techniques, industrial applications of thermoelectricity, and electronic sources of industrial heat.

Construction of UEC Progresses

THIS photo of the United Engineering Center (UEC) was taken March 27 from the north east corner of 48th Street and United Nations Plaza in New York City. Completion of the 20-story structure is expected this year. This slim tower of glass, stainless steel, and limestone rises from a broad 2-story base of glass and stone. The new building, which is 283 feet high, will provide 260,000 square feet of floor space. This structure will replace the 52-year-old Engineering Societies Building on 39th Street which houses some of the societies which will locate in the new Center. Eighteen American engineering groups will occupy the new building.

Wagner International

1st Packaging Industry Conference To Take Place May 15-16 in Swampscott

GREATER operating efficiency and reduced maintenance costs connected with packaging equipment is the aim of the first annual Packaging Industry Technical Conference to be held at the New Ocean House, Swampscott, Mass., on May 15-16. The conference will be conducted by the Packaging Industry Subcommittee of AIEE and attended by electrical engineers and packaging people from electric equipment manufacturing firms, packaging machinery producers, and users of packaging equipment.

The rapid rise of automation in the packaging line has increased the problems of specification and maintenance of electric equipment used in connection with or as part of packaging machinery. This is of growing concern to electric equipment suppliers, packaging machine manufacturers, and the packagers employing the equipment. The solution may lie in promoting recommended practices and minimum standards of the electric equipment.

The program for the 2-day technical conference has been announced by E. B. Gardner, assistant development manager, Emhart Manufacturing Company, who is chairman of the conference. J. D. Ramsay, manager of electrical engineering, Campbell Soup Company, is chairman of the Packaging Industry Subcommittee.

The conference is endorsed by the Packaging Institute and the Packaging Machinery Manufacturers Institute.

Registration forms and programs are available from the registration chairman, W. A. Warren, engineering department, R. J. Reynolds Tobacco Company, Winston-Salem, N. C.

The tentative program for the conference follows:

Monday, May 15

9:00 a.m. Registration

10:00 a.m. Welcome

R. A. Pfuntner, chairman, Lynn Section AIEE.

J. D. Ramsay, chairman, AIEE Packaging Industry Subcommittee.

10:00 a.m. Morning Session

Chairman: M. H. Fisher, Westinghouse Elec. Corp.

Trends in Electrification of Packaging Machinery. *T. W. Brockmeier*, National Biscuit Co.

Electrical Standards for the Packaging Industry.

a. From the Users Standpoint. *E. W. Dacey*, Procter & Gamble.
b. From the Machinery Manufacturer's Standpoint. *Boyce Brandom*, Portland Div., Emhart Mfg. Co.
c. From the Electrical Suppliers Standpoint. *C. M. Rhoades*, General Elec. Co.

12:30 p.m. Lunch

Speaker: L. H. Zahn, president, Packaging Institute.

2:00 p.m. Afternoon Session

Chairman: Don Percival, Machinery Electrification, Inc.

How Electrical Standards Were Formed for the Textile Industry. *V. F. Sepavich*, Crompton & Knowles Corp.

Wiring Diagrams, Symbols, Circuitry. *Frank Cinco*, Package Machinery Co.

Control Enclosures and Panel Wiring Methods. *D. C. Walker*, Square D Co.

Conduit and Wiring Systems for Packaging Machinery. *Lester Higgins*, Scandia Packaging Machinery.

Short-Circuit Protection for Packaging Machine Controls. *H. R. Sinclair*, Westinghouse Elec. Corp.

6:30 p.m. Social Hour

Courtesy of electrical suppliers.

7:30 p.m. Banquet

Toastmaster: E. B. Gardner, Emhart Mfg. Co.

Speaker: LCDR G. H. B. Shaffer, director, Fleet Ballistic Missile Nuclear Propulsion Dept., U.S. Naval Submarine Base, New London, Conn.

Subject: "The USS SKATE's Arctic Cruises."

Tuesday, May 16

9:00 a.m. Morning Session

Chairman: Ira Gottscho, Adolph Gottscho, Inc.

Heating Devices and Their Application.

a. Clamp-On Heaters. *S. Campanella*, Edwin L. Weigand Co.
b. Cartridge Heaters. *W. L. Greene*, Watlow Elec. Mfg. Co.
c. Cast-In Heaters. *G. C. Scribner*, Vulcan Elec. Co.
d. High-Frequency Heat. *J. D. Manwaring*, Radio Frequency Co., Inc.
e. Impulse Heating. *Alfred Fener*, Vertrod Corp.

Use and Misuse of Limit Switches. *W. F. Huette*, Allen-Bradley Co.

New Products.

a. Thermistor Temperature Controllers. G. S. Freeman, Fenwall, Inc.
b. "SONAC," Ultrasonic Sensing and Switching. *W. C. Hunsicker*, Electro-Sonics Div., Delavan Mfg. Co.
c. A New Compact Relay Type BF. *Keith McCall*, Beaver Works, Westinghouse Elec. Corp.
d. Silicon Controlled Rectifier Adjustable Speed Drive. *Ronald Mengel*, Specialty Control Dept., General Elec. Co.

12:30 p.m. Lunch

Speaker: W. W. Anthony, Jr., vice president, PMMI.

2:00 p.m. Afternoon Session

Chairman: E. D. Wilcox, Jr., Lever Brothers Co.

Selection and Application of Solenoids. *Rene Castenschiold*, Automatic Switch Co.

Photoelectric Registration. *D. P. Wise*, Barkley & Dexter Labs.

New Products.

a. Plug-in Limit Switches. *R. C. Froehlich*, Micro Switch Div., Minneapolis-Honeywell Regulator Co.
b. Compact Photoelectric Control. *Richard Connell*, Machinery Electrification, Inc.
c. Combination Electric Clutch-Brake. *F. D. McCormick* Stearns Elec. Corp.
d. Bead Chain Timer (Eagle Signal Co.) *Warren Hallock*, Gibson Engineering.

1,000 Participants Are Expected at 5th Symposium on Global Communications

ARRANGEMENTS have been completed for the 5th National Symposium on Global Communications (Globecom V), which will convene May 22-24 at the Hotel Sherman in Chicago, Ill. The conference is being sponsored by AIEE and the Professional Group on Communications Systems of the Institute of Radio Engineers (IRE).

According to Dr. W. L. Firestone, general chairman of Globecom V, more than 1,000 engineers, scientists, and managers are expected to participate in the symposium. Eighteen sessions of technical papers, covering all phases of the communications art, will be presented. Space communications, switching and transmission systems, and data handling will be featured under the theme "Communications on a Global Scope."

Dr. Mueller To Speak

The central social function will be the symposium luncheon on Tuesday, May 23, at which Dr. G. E. Mueller, vice-president, Space Technology Laboratories, Los Angeles, Calif., will be the principal speaker. In addition to the technical papers program, some two dozen manufacturing and engineering organizations will be displaying the latest in communications equipment, processes, and technical advances.

Dr. Firestone announced that a Convention Record, containing abbreviated versions of each paper, will be provided to all participants as they register at the conference. This will aid the speakers and audience in maintaining the high professional setting for the symposium.

Moderators for the technical sessions have been announced by Donald Campbell, program chairman. They are:

R. D. Campbell, American Telephone and Telegraph Company—Space Communication I; R. E. Stoffels, Automatic Electric Laboratories—Data Transmission; A. A. MacDonald, Motorola, Inc.—Communications Systems; W. K. MacAdam, American Telephone and Telegraph Company—A Large Scale Four-Wire Switched Communications Network for Military Communications; J. N. Petrie, Automatic Electric Company—System Performance; W. Lyons, Radio Corporation of America—H. F. Communications; Prof. E. C. Jordan, University of Illinois—Space Communication II; Col. J. Z. Millar, Western Union—Modulation Techniques; and Col. W. D. Joslin, U. S. Army Signal Corps—Pacific Scatter Communications System; H. F. May, Bell Telephone Laboratories—Switching Systems I; Paul Hurtel, Jr., Collins Radio Company—Microwave Radio Relay; Dr. H. P. Messinger, International Telephone and Telegraph Company (ITT), Kellogg—Reliability; R. L. Vader, Lockheed Aircraft Corporation—Space Communication III; V. N. Vaughan, American Telephone and Telegraph Company—Data Handling; N. B. Tharp, Westinghouse Electric Corporation—Forward Scatter; R. D. Slayton, Teletype Corporation—Switching Systems II; Prof. A. H. Rubenstein, Northwestern University—System Planning, and R. C. Benoit, Jr., U. S. Air Force, Rome Air Development Center—Speech Compression and Spectrum Sharing.

Symposium Committee Named

The Symposium Committee is composed of: General Chairman—Dr. W. L. Firestone, Motorola, Inc.; AIEE Vice-Chairman—S. R. Collis, Illinois Bell Telephone Company; IRE Vice-Chairman—R. H. Maier, ITT-Kellogg; Executive Secretary—C. F. Wittkop, Motorola, Inc.; Technical Program Chairman—D. C. Campbell, ITT-Kellogg; Arrangements Chairman—R. J. Hajek, Commtronix Engineering; Public Relations & Publicity—R. D. Slayton, Teletype Corporation; Publications Chairman—E. F. Dirsa, Admiral Corporation; Finance Chairman—R. E. Morrison, Illinois Bell Telephone Company, and Exhibits Chairman—F. L. Hilton, Motorola, Inc.

Further details on the program and registration may be obtained from the Executive Secretary, C. F. Wittkop, Motorola, Inc., 1450 N. Cicero Ave., Chicago 51, Ill.

List Railroad Computer and Automation Conference

The Railroad Computer and Automation Conference will be held June 6-7 in the Cleveland Engineering Society Building, Cleveland, Ohio.

This conference is being sponsored by AIEE's Land Transportation Committee.

Technical sessions will be held June 6. Inspection trips to the C&O Computer Center and the CTS Rapid Transit System are scheduled for June 7.

The tentative technical program follows:

New York City Transit Authority Automated Train. *R. G. Welch*

Opportunities for Computer in Land Transportation. *R. S. Gillette*

Experience of the French National Railroads in the Field of Remote Controlled Train Operations. *J. C. Blumstein*

Automation of Material Handling for Railroad Facilities. *G. E. Author*

Recent Developments in the Operation of Unmanned Locomotives and Trains. *L. R. Allison,* Union Switch & Signal Co.

Heuristic Train Dispatching. *J. L. Gable*

This meeting will be informal and conducted like a seminar.

A luncheon will be served at the Cleveland Engineering Society Building.

Hotel arrangements should be made by the registrants. The Pick-Carter Hotel is suggested.

The registration fees will be $3 for AIEE members and $5 for nonmembers.

Conference To Discuss 'Magnetics in the Space Age'

The 6th annual technical conference on nonlinear magnetics will be held at the Statler-Hilton Hotel, Los Angeles, Calif., November 6-8. This conference is under the sponsorship of AIEE and the Institute of Radio Engineers. Its theme will be "Magnetics in the Space Age."

Dr. T. Bernstein has been named technical chairman and is soliciting papers dealing with nonlinear magnetics, magnetic amplifiers, computer applications, combined semiconductors and nonlinear magnetics. Paper manuscripts are due on June 1. Papers and questions should be submitted to Dr. T. Bernstein, Space Technology Laboratories, Inc., P. O. Box 95001, Los Angeles 45, Calif.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until May 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before May 26.

60-832 **Determination of Economical Distribution Substations Size.** *J. A. Smith*

60-833 **Economics of Primary Distribution Voltages of 4.16 Through 34.5 Kv.** *J. A. Smith*

61-143 **The Effects of Temperature, Humidity, and Current on Collector Ring and Brush Wear.** *D. J. Herder, W. Kerber, Jr.*

61-204 **The Surge Comparison Testing of Several Types of D-C Armature Windings.** *F. A. Sheda*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

EJCC Theme Reflects Trends in Computer Technology

The 1961 Eastern Joint Computer Conference (EJCC) has announced that the theme for this year's conference, to be held December 12-14 at the Sheraton-Park Hotel in Washington, D.C., will be: "Computers—Key to Total Systems Control."

B. G. Oldfield, program chairman, stated that this theme reflected one of the most significant trends in modern computer technology. "Until quite recently, computers were considered to be data processing ends in themselves," Mr. Oldfield pointed out. "Now they are more and more being treated as merely one element—although the most vital one—in total systems for government, defense, industry, and business management operations. Other important elements in the closed loop of the 'total system' are data acquisition, digital data communications, display, and actual control or guidance."

The 1961 EJCC will follow this total systems approach by presenting the latest advances in equipment and concepts leading toward computer control of present and future systems. Mr. Oldfield called for papers in such representative areas as: business management control, military and space command control systems, industrial process control, real time systems, network control, man-machine systems, self-organizing systems, high-speed digital data, and communications.

Each person wishing to contribute a paper to the program should submit two copies of both a 100-word abstract and a 2-page summary to: B. G. Oldfield, IBM Federal Systems Division, 326 E. Montgomery Ave., Rockville, Md.

The deadline for submission of abstracts and summaries is June 20. Authors whose papers are chosen for presentation will be promptly notified.

Inasmuch as papers will be published prior to the conference and made available to the attendees, the full text of papers chosen for presentation must be submitted to the program chairman by September 1.

Conference Planned on Electronic Components

The Electronic Components Conference, to be held May 2-4 in the Jack Tarr Hotel, San Francisco, Calif., will cover the following three themes:

1. New components and their impact on engineering progress.
2. New products and new requirements to meet the demands of our new engineering age.
3. New techniques which make new components possible.

H. C. Ross, newly appointed chairman of this conference, has advised that the meeting will include papers on the following: components using magnetic principles; semiconductors; microwave; high-voltage components; switching relays, control devices; pulse components; new components for power generation; space components and requirements; reliability of components; capacitors, resistors, and potentiometers; supercooled components, cryogenics; hardware plugs, terminals, printed circuits, wire, etc.; filters; microminiature components; optical, magneto-optical, and light sources; instruments and standard measuring devices; vacuum components and equipment; tubes other than microwave, and data-processing components.

The conference is sponsored by AIEE, Electronic Industries Association, Institute of Radio Engineers, and West Coast Electronic Manufacturers Association.

Further information can be obtained from H. C. Ross, Jennings Radio Manufacturing Corporation, P. O. Box 1278, San Jose 8, Calif.

Charter Presentation Is Feature of Section Meeting

A charter presentation was the main feature of the Annual Executive and Committee Chairmen Meeting of the Connecticut Section, AIEE, which was held at the Hawthorne Inn in Berlin, Conn., on March 7.

Fred Bacon, chairman of the North Eastern District, AIEE, presented the charter establishing a Student Branch at the University of Bridgeport, to Thomas Hunter, AIEE Student Chairman, University of Bridgeport. Councilors, Student Branch of Co-operation Committee chairmen, and Student Branch chairmen representing many colleges throughout Connecticut were present.

This annual get-together offered an opportunity for the working members of the Section to meet one another again and arrive at new and easier ways of co-ordinating their respective activities.

Each committee reported on its respective activities and responsibilities, outlined the method employed in carrying out these responsibilities, and also mentioned the difficulties an individual committee may have in carrying out its plans. Meetings of this type afford the opportunity for more members to become familiar with the workings of their Section and gain a better understanding of mutual problems.

F. S. Bacon, vice-chairman, AIEE, was a guest of the Connecticut Section. Mr. Bacon presented a discussion regarding the history and future of AIEE.

Annual NEC To Be Held on October 9-11 in Chicago, Ill.

The 17th Annual National Electronics Conference (NEC) will be held October 9-11 at the International Amphitheatre, Chicago, Ill.

The papers program of NEC will cover the entire range technology of interest to electronic engineers. This will include components, devices, design, techniques, applications, and management.

Indicative of the scope of the conference are the following topics: antennas, modern microwave techniques, millimeter wave techniques, optical communications, audio and ultrasonic engineering, magnetohydrodynamics, logic and switching theory, digital computer design, digital computer techniques, digital system components, digital data transmission, data processing, microelectronics, solid-state devices and circuits, transistor circuit application, parametric devices and techniques, space communications, man in space, engineering management, learning and adaptive systems, engineering cryogenics, network theory, amplifier circuit theory, and instrumentation.

Two $500 awards will be presented for the best papers submitted at the 1960 NEC. L. P. Huelsman of the University of Arizona was named as the author of the best over-all paper, entitled "Active RC Synthesis with Prescribed Sensitivity."

The author of the best tutorial paper

OFFICERS of the Connecticut Section, AIEE, who attended the annual meeting, are: (*seated, left to right*) L. B. Grew, chairman; F. S. Bacon, North Eastern District chairman; (*standing, left to right*) D. E. Ostrom, secretary; Q. Q. Quinn, past chairman; Arthur McClaren, vice-chairman, and L. R. Jones, treasurer.

for 1960 is Dr. R. M. Lerner of the Massachusetts Institute of Technology, whose paper is entitled "Modulation and Signal Selection from Digital Data Systems."

The authors' privileges will include publication of the papers in the *Proceedings*, complimentary advance registration, complimentary copies of the *Proceedings*, and the authors' ribbon badges.

Two copies of the completed paper for publication in the *Proceedings* should be submitted by September 6. The papers should be submitted to: W. L. Firestone, Motorola, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.

C. W. McClure Selected for 1961 NEC Fellowship Award

C. W. McClure of Chicago, Ill., an electrical engineering graduate student at the University of Wisconsin at Madison, Wis., has been awarded the 1961 Natonal Electronics Conference (NEC) Fellowship Award.

A second lieutenant in the Signal Corps Reserve, Mr. McClure received his B. S. degree in electrical engineering in 1960, and his M. S. degree in February of this year at the University of Wisconsin. He is now studying for his doctorate.

The NEC each year presents a Fellowship, valued at $2,500, to an outstanding graduate in electrical engineering to further his studies in electronics. The Fellowship covers a year of graduate study at any of the 10 colleges and universities participating in the NEC.

Mr. McClure is continuing his studies in the area of non-numerical application of digital computers and artificial intelligence. He has held the offices of president of Theta Chapter of Eta Kappa Nu, and parliamentarian of the Wisconsin Alpha Chapter of Tau Beta Pi. For the past 2 years he has been employed by the Digital Computer Laboratory at the University.

Space Expert Speaks at Los Angeles Section Meeting

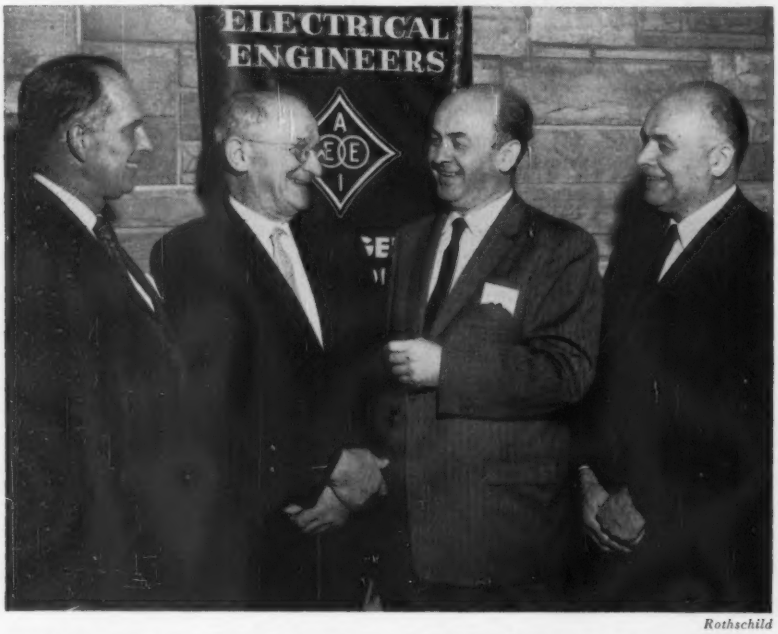
Adventurous spirits were stimulated with visions of lunar landings at the March 14 dinner meeting of the AIEE Los Angeles Section. Space exploration in general and the Saturn project of the National Aeronautics and Space Administration (NASA) in particular were discussed by Josef Boehm, space expert from the Marshall Space Flight Center at Huntsville, Ala.

Mr. Boehm is chief of the Electromechanical Engineering Branch of the Guidance and Control Division at Huntsville. He came to the United States in 1945 after extensive experience in German rocket developments.

During his presentation, Mr. Boehm drew a comparison between the United States and Russia in the rocket field. He commented that while the Russians have been able to place larger payloads in orbit than the United States, this nation has been successful in orbiting greater numbers of satellites. With a capability of placing a 10-ton satellite in orbit around the earth, the Saturn vehicle when completed will place the United States on an essentially equal footing with the Russians in the space field.

Though relatively complex, the Saturn vehicle is expected to offer high reliability. This is due to a design concept which calls for the adoption of proven guidance, control, and other elements from existing space vehicles. Not only does this approach enhance system reliability, but it does so at a substantial savings of taxpayers' dollars. Under current schedules, Mr. Boehm anticipates that the Saturn vehicle will become an operational system by the latter part of 1964.

During the program, color slides were employed to describe various details of the Saturn project. Among these were artist's conceptions which depicted the Saturn effecting moon landings of both instrumented scientific equipment and manned vehicles. The scientific probes will be designed to disclose surface environmental conditions prior to any manned mission to the moon.



Rothschild

NASA'S project Saturn was revealed to the AIEE Los Angeles Section at its March 14 dinner meeting. Shown discussing meeting arrangements are: *(left to right)* F. L. Goss, Section secretary-treasurer; Robert Milmoe, Section chairman; Josef Boehm, and L. L. Grandi, Section vice-chairman.

Electronics R & D Study Sponsored by NEC in Chicago

The National Electronics Conference, Inc. (NEC), and a local group of engineering management personnel are sponsoring a Chicago, Ill., area electronic research and development study known as the "NEC Electronics R & D Study." The purpose of the study is to analyze the current status of Chicago area electronics in order to determine whether its research and development potential is being adequately realized, and to add to the present understanding of the relationships between research and development in industry and the benefits of such research and development to the industrial firm and to society.

The R & D survey is currently being conducted under the guidance of A. H. Rubenstein, professor of industrial engineering, Northwestern University. Prof. Rubenstein has had significant experience in conducting similar surveys in other geographical areas. An important part of the study consists of personal interviews with management of Chicago area electronic companies.

Impetus for the study came from the belief of a number of engineering management and NEC members that the amount and quality of electronic research and development in the Chicago area is lower than that of other electronic centers, despite the obvious dominance of the Chicago area in production and sales of electronic products. Prof. Rubenstein expects that the results of the study, which is being supported by funds solicited from electronic organizations and corporations in the Chicago area, will be available in time to be presented at the 1961 NEC to be held at the International Amphitheatre in Chicago on October 9-11.

Sponsors of the NEC include: AIEE, the Illinois Institute of Technology, the Institute of Radio Engineers, Northwestern University, and the University of Illinois. Participants of the conference are: Iowa State, Marquette, Michigan State, Purdue, Michigan, Notre Dame, Wisconsin, and Wayne State universities; the Electronic Industries Association, and the Society of Motion Picture and Television

Engineers. R. J. Napolitan is general manager of the conference.

Further information on the conference may be obtained from: A. A. Macdonald, Chicago Center, Motorola Military Electronics Division, 1450 North Cicero Ave., Chicago 51, Ill.

Measurement Science Center Provides Education and Research

Established by George Washington University in September 1960, the Center for Measurement Science is a co-operative activity of the university, industry, and government, which provides education, research, and service programs related to measurement.

The Center is operated by the university as a part of its School of Engineering and was established with the collaboration of the National Bureau of Standards and the financial support of a grant from the Martin Company, Baltimore, Md.

The Center for Measurement Science serves the primary function of improving, expanding, and disseminating knowledge in the field of measurement science, for the purpose of increasing the measurement capability of mankind. It performs this function, as well as subsidiary functions, through broad activities in three programs—education, research, and service.

The principal activities of the Center are, as follows:

1. The education of persons for careers in measurement science.

2. The development and improvement of measurement, standardization, and calibration techniques, apparatus, and data, with particular reference to high precision.

3. The provision of staff and facilities available to industry for research and consultation on measurement problems in industry, and including the maintenance of primary standards of measurement directly traceable to the national standards.

4. The publication of results of research, manuals of practice and procedures, and information related to measurement science.

J. M. Nelson Selected for 'Engineer of the Year' Award

J. M. Nelson (AM '43, M '49), executive assistant superintendent for Seattle City Light, Seattle, Wash., has been selected for the "Engineer of the Year" award of the Washington Society of Professional Engineers.

Each year, the society presents the award to a member of one of the Seattle technical societies. The award is presented at the annual banquet of the Puget Sound Engineering Council during Engineers' Week.

Mr. Nelson entered the employ of Seattle City Light in 1936 as an operator's helper. He progressed through various grades to the position of senior engineer, and in 1948 was appointed assistant superintendent in charge of engineering and operations. In 1955, he was appointed to his present position as executive assistant superintendent.

A licensed professional engineer in the State of Washington, Mr. Nelson is a past president of the Electric Club of Washington, now the Puget Sound Electric League, and a member of the Engineer's Club.

He has served as an AIEE vice-president (1958-60).

Theme of 1961 NTC To Be on Science and Education

The theme of the National Telemetering Conference (NTC), to be held May 22-24 at the Sheraton Chicago Hotel, Chicago, Ill., will be "Science and Education in Telemetry."

NTC is being sponsored by five technical societies: AIEE, the Institute of Radio Engineers, the American Rocket Society, the Institute of the Aerospace Sciences, and the Instrument Society of America.

The tentative technical program follows:

Monday, May 22

9:30 a.m. Sessions

Workshop: Telemetery Standards. *A. E. Bents,* Sandia Corp.

Industrial Telemetering. *W. E. Phillips,* Leeds & Northrup Co.

2:00 p.m. Sessions

Transducers. *R. G. Jewell,* General Elec. Co.

Advanced Systems Techniques I. *William Van Dyke,* Douglas Aircraft Co.

Data Processing and Presentation. *T. J. Martin,* Boeing Airplace Co.

Tuesday, May 23

9:00 a.m. Sessions

Workshop: Telemetry in Europe. *A. P. Gruer,* Sandia Corp.

Signal Conditioning. *R. W. Sanders,* Space Electronics

Flight Test Data Systems. *John Mallernee,* North Amer. Aviation.

1:30 p.m. Sessions

Workshop: Telemetry Education, *W. J. Mayo-Wells,* George Washington Univ.

Advanced Systems Techniques II. *A. C. Cole,* Martin Co.

Wednesday, May 24

9:00 a.m. Sessions

PCM Systems I. *M. G. Pawley,* U. S. Naval Ordinance Lab.

Underwater Measurement. *M. A. Lowy,* consultant

2:00 p.m. Sessions

Biomedical Telemetering. *Miles McLannan,* Wright Patterson Air Force Base

PCM Systems II. *Fred Karabaich,* Wright-Patterson Air Force Base

R-F Components and Techniques. *Thomas Eccles,* Microdot

Engineering Societies Urged To Give Counsel to President

W. V. Kahler (M'39, F'46), president of Illinois Bell Telephone Company, has urged five leading professional engineering societies to volunteer counsel to President Kennedy and Congress in technical assistance programs. Mr. Kahler also suggested that retired engineers might be tapped for leadership in technical phases of the President's peace corps and other foreign aid operations.

The telephone company executive spoke before 600 persons in the Furniture Club of America, Chicago, Ill., at a dinner at which he was presented the 1961 Washington Award—one of the nation's outstanding honors for engineers—by R. D. Maxson, president of the Western Society of Engineers.

The award is conferred upon an engineer for "accomplishments which preeminently promote the happiness, comfort and well-being of humanity."

Mr. Kahler was chosen by the Washington Award Commission representing AIEE, the Western Society of Engineers, American Society of Civil Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, and American Society of Mechanical Engineers. Mr. Kahler, born on a Missouri farm, spoke on "Plowing a Straight Furrow," which he said meant "striving to meet the highest possible standards of excellence."

He suggested that the five engineering societies form a joint committee "to volunteer guidance and counsel to the Administration and Congress in the selection of the best methods of rendering technical assistance abroad."

Mr. Kahler pointed out that such a committee could bring together a wide range of engineering wisdom and experience.

"The international field is fertile ground into which professional engineering societies might well sink their plowshares, and with their skills open up new areas in which freedom and respect for human dignity will flourish," he said.

Missouri Honor Award Presented to V. H. Disney

V. H. Disney (M '50), director of the Electronics Research Division, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill., has been presented with a Missouri Honor Award for Distinguished Service in Engineering by the College of Engineering and the Engineering Foundation of the University of Missouri.

Mr. Disney was cited for "his successful and outstanding career in the field of electronics research; his engineering and management contributions to the development of electronic computers, automation and communication systems; his administrative and engineering skill as director of the Electronics Research Division of the Armour Research Foundation and as president of the National Electronics Conference."

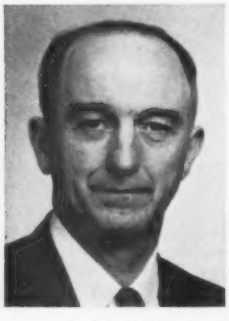
AIEE FELLOWS ELECTED

Board of Directors Meeting, January 27, 1961

Carl Edward Asbury (AM '39, M '46), chief electrical engineer, Commonwealth Associates Inc., Jackson, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the field of power engineering and to national and international standards." He was born in Tamaroa, Ill., on June 7, 1912, and received his B.S. degree in electrical engineering from the University of Illinois in 1938. Upon graduation, he was employed by the Illinois-Iowa Power Company, which later became the Illinois Power Company, Decatur, Ill., where he worked as a graduate engineer for a year and as an assistant engineer in the operating, maintenance, and construction departments for the following year. During 1941-46, he was a relay engineer for the company, in charge of all relay applications, settings, short circuit studies, and relay test crews, and assisted with system operating problems and some planning problems. For the first 4 years of this period, he was also an electrical engineering instructor in the Engineering Extension for evening classes at the University of Illinois. In 1946, he joined Commonwealth and Southern Corporation, Jackson, Mich., and for the next 5 years was responsible for technical studies and application of major electric equipment. During 1951-56, he was principal engineer with Commonwealth Associates, Inc., formerly Commonwealth and Southern Corporation, as a supervisor in charge of major electric equipment application, estimating, technical studies, and investigations. Until 1958, he served as electrical systems engineer in charge of the system planning section. In 1960, he was advanced to his present assignment as chief electrical engineer in charge of the electrical portion of power plants, substations, transmission lines, application and design, as well as major electric equipment application, specifications, estimating, relay setting, technical studies, and investigations. He is a member of Eta Kappa Nu and the National Society of Professional Engineers. Mr. Asbury has been chairman of the C50 Subcommittee on Synchronous Machines of the American Standards Association. In 1958-59, he was the U. S. delegate to the International Electrotechnical Commission. Mr. Asbury has served on the following AIEE Committees: Relay (1949-51), Rotating Machinery (1951, 1956-57), Switchgear (1952, 1956-61), Power Generation (1952, 1956-57), Substations (1953, 1956-57), Dielectrics (1955-56), and Standards (1959-61).

Theron Adelbert Brown (M '31), president and general manager, Madison Gas and Electric Company, Madison, Wis., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design of distribution systems, substations and power plants." He was born May 7, 1896, in Spring Green, Sauk County, Wis., and graduated from the University of Wisconsin in 1923 with the B.S. degree in electrical engineering. During 1921-23, he was a student employee of Madison Gas and Electric, assigned to drafting and maps and records. In 1923, he became superintendent, gas and electric distribution, a position he held until 1942. Mr. Brown was responsible for the long- and short-range system gas and electric system design and construction, which included design and construction of a low-voltage a-c underground electric distribution system. He was in charge of the design and construction of a 4-kv primary distribution system network supplied from unit-type distribution substations. Following this, he worked on the design and construction of 825 psi, 825 F steam generating turbine and boiler addition, electric generating plant, and subsequent additions of generating capacity totaling 70,000 kw. In 1942, he was promoted to general superintendent and chief engineer, and was assigned to the design and construction of a 1,250-psi 1,000 F generating plant addition totaling 88,000 kw. Mr. Brown became president and general manager in 1958, the position he now holds. He is responsible for general management at the policy-making level, all operations, engineering, system planning, and financing. A registered professional engineer of the State of Wisconsin, he is a member of the Wisconsin Society of Professional Engineers, the Engineering Society of Milwaukee, and Eta Kappa Nu. He has held the office of vice-president and president of the Wisconsin Utilities Association, and was chairman of the Madison Section, AIEE, in 1934. In 1959, he was awarded a citation by the University of Wisconsin for service in engineering.

William Russell Clark (AM '37, M '44), manager, Product Engineering Division, Leeds and Northrup Company, Philadelphia, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions by invention, development and design to recording, measuring and control instruments and systems." Born November 28, 1907, in Trainer, Pa., he studied electrical engineering at the University of Pennsylvania from which he received the B.S., M.S., and Sc.D degrees in 1929, 1932, and 1938, respectively. Dr. Clark joined Leeds and Northrup in 1929 as a research assistant. In 1932, he became associated with the Franklin Institute Museum staff and took charge of the Electricity and Magnetism Section of the physics department. He returned to Leeds and Northrup in 1934 as an electrical research engineer. In 1945, he became supervisory research technologist of the Electrical Division of their research department, and in 1952 was appointed chief. He was named chief of the Electro-Mechanical Division of the research and development department in 1955, became assistant chief engineer in 1956, and was appointed manager of the Product Engineering Division in 1956. Dr. Clark is a senior member of the Institute of Radio Engineers, a member of the Instrument Society of America, and the Engineers Club of Philadelphia. He has served on the Panel on Test Equipment of the Research and Development Board of the U. S. Military Establishment. He has been secretary and chairman of the Philadelphia Section, AIEE. Currently serving as treasurer (1960-61) of the Institute, he has served as an AIEE director (1956-61), and has been a member of the following AIEE Committees: Electronics (1945, 1948-55, 1958-61); Instruments and Measurements (1947-55, chairman 1949-51); Technical Program (1949-50); Standards (1949-50); Science and Electronics Division (1949-57, chairman 1952-54); Technical Operations (1952-61, chairman 1956-57); Instrumentation Division (1956-57); Recording and Controlling Instruments (1956-57); Board of Directors (1956-57, 1961); Planning and Co-ordination (1956-60); Constitution and Bylaws (1957-58); Recognition Awards (1957-58); Finance Committee (chairman 1958-60); Executive Committee (1959-60); and District representatives to the Technical Operations Department (1960-61).



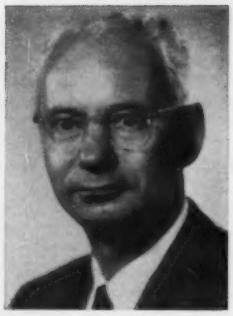
C. E. Asbury

DeLonge

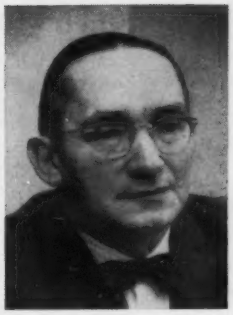
T. A. Brown

W. R. Clark

A. J. Cooper



R. K. Hellmann



J. J. A. Jessel

J. W. Jones

Archibald John Cooper (AM '25, M '50, Member for Life), retired manager of the Empire Region of the Allis-Chalmers Manufacturing Company, has been transferred to the grade of Fellow in the AIEE ". . . for contributions toward the practical application of electrical machinery." Born April 25, 1888, in Sydney, Australia, he attended Sydney Technical College. He was associated with the New South Wales Government Railways and Tramways before coming to the United States in 1909. Mr. Cooper was employed by the Seattle Electric Company, Stone & Webster Division, and then joined Allis-Chalmers in Milwaukee, Wis., as member of the Graduate Training Course. He was employed in the electrical estimating and service department until he was transferred to the Boston Sales Office in 1912. As a sales representative of Allis-Chalmers, Mr. Cooper was instrumental in the following: He introduced steam turbines in the New England textile mills. He introduced modern high-efficiency waterwheels with vertical shaft generators in various pulp and paper mills and textile mills in New England. He co-operated with Charles T. Main of Boston in electrifying old cotton mills that were primarily mechanically driven. Mr. Cooper also introduced the first high-efficiency motor-driven centrifugal pumps into pulp and paper mills, and the first self-starting synchronous motors for installation in rubber plants. In 1920, he came to New York as a salesman for Allis-Chalmers and handled all the major utilities, holding companies, and consulting engineers. He helped bring to New York engineers the many advances in steam and hydraulic turbine design. During World War II, he introduced the 21 gas turbine generating units for installation in oil refineries to utilize the by-product hot gases. He became assistant manager and then manager of the Allis-Chalmers New York Sales Office. When the region system was developed, he was made manager of the Empire Region, and recently retired after 50 years with the company. He is a member of the Montclair, N. J., Society of Engineers.

Reinhard K. Hellman (AM '37, M '45), vice-president and director, Hazeltine Research Corporation, Little Neck, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of civilian and military electronics." He was born August 25, 1909, in Aachen, Germany, and received the degrees of Dipl. Ing. in electrical engineering and Dr. Ing. in 1932 and 1937, respectively, from the Institute of Technology in Aachen. In 1933, he joined the technical staff of Siemens & Halske A.G. in Berlin, Germany, where he was concerned with the development of carrier-frequency telephone equipment and instrumentation for acoustical measurements. When he came to this country in 1937, he became an electronics consultant with Tris Sales Corporation, New York City. In 1939, Dr. Hellmann became assistant chief engineer of the Connecticut Telephone & Electric Corporation, Meriden, Conn., where his responsibilities included development and production engineering of military telephone and switchboard equipment as well as the development of a high-speed recorder and components for the telephone field. In 1947, Dr. Hellman joined Hazeltine Electronics Corporation where he was first engaged in circuit development for television receivers, and in 1949 he became chief engineer of the Hearing Aid Division. He was assigned as chief test engineer in 1951, and in this capacity he organized a department responsible for development of testing methods and equipment for the company's military electronics activities, which included the establishment of an electronic standards and environmental testing laboratory. Promoted to assistant vice-president of the operating subsidiary, Hazeltine Electronics Division, he became responsible for the Technical Publications Department and for the administration of proposal evaluation. In his present position as vice-president and director of Hazeltine Research Corporation, he is concerned with the direction and administration of research in electronic systems and apparatus for military and industrial applications. He is also a vice-president of Wheeler Laboratories, another Hazeltine subsidiary engaged in the development of antennas and microwave components. Dr. Hellman is a Fellow of the Institute of Radio Engineers. He has served on the following AIEE Committees: Television and Aural Broadcasting Systems (1952-57), Communication Theory (1955-60, chairman 1957-59), Electronic and High Frequency Instruments (1956-61), and Communication Division (1957-61).

Joseph J. A. Jessel (AM '37, M '48), head, Section of Transmission and Co-ordination, Bureau of Power, Federal Power Commission, Washington, D. C., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the co-ordination of power generation and transmission." He was born December 20, 1907, in Lawrence, Mass., and received the electrical engineering degrees of S.B. in 1931, S.M. in 1932, and Sc.D. in 1934, from the Harvard Engineering School, Harvard University. After summer work with the Edison Electric Illuminating Company and Boston Elevated Railway Company, Mr. Jessel joined the staff of the Federal Power Commission in 1934 as a junior engineer with the National Power Survey to work on electric power transmission. In 1936, he was transferred to the San Francisco Regional Office of the Commission where he became assistant electrical engineer specializing on power market surveys, electrical features of licensed hydroelectric projects, and unusual electrical design problems. By 1941, he was promoted to associate electrical engineer and electrical engineer. In 1942, Mr. Jessel was transferred to the Washington, D. C., office of the Commission where as senior electrical engineer he was in technical charge of transmission and engineering phases of war-power contracts for electric service to war industries. In 1945, he became principal electrical engineer and head of the Transmission and Co-ordination Section, in charge of interconnection and co-ordination studies, high-voltage transmission studies, and electric facility work. He has had prime responsibility with the Commission for advancing the interconnection and co-ordination of electric utility systems on an area and regional basis and the co-ordination of power generation and transmission for most economic use of the natural resources. He has appeared as an expert witness at Commission hearings before examiners and before committees of Congress. He has been a member since 1942 of the faculty of the Graduate School, U. S. Department of Agriculture. A registered professional engineer in California and Washington, D. C., Mr. Jessel is a member of the Washington Society of Engineers, the Harvard Engineering Society, and Tau Beta Pi. He has been chairman of the Audit and Press Relations Committees of the D. C. Council of Engineering and Architectural Societies.

John Wandesford Jones (AM '22, M '50, Member for Life), senior engineer, Philadelphia Electric Company, Philadelphia, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the basic development of a major electric generating and transmission system and to standards for rotating machines."

Born July 16, 1894, in Camden, N. J., he received the B.S. degree in electrical engineering from the University of Pennsylvania in 1920. Mr. Jones has been associated with Philadelphia Electric since 1920 when he started as an electrical inspector in the Station Construction Division and was transferred in 1923 to the Electrical Engineering Division. His activities in the Electrical Engineering Divison have related chiefly to the design and engineering of generating stations, substations, and associated transmission system, with special attention to the rotating electric machines. He is a registered engineer in the State of Pennsylvania and is a member of Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. Mr. Jones is a member of the American Standards Association's Sectional Committee C50—Rotating Electrical Machinery. He has served on the AIEE Protective Devices Committee (1947-48) and Rotating Machinery Committee (1947-59).

George Avenel Lewis (M '48), supervisor of power, Region 6, Bureau of Reclamation, Billings, Mont., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the planning and design of a large hydro-electric power generation and transmission system." Mr. Lewis was born in Cuba, Ill., on February 24, 1909, and received the B.S. degree in electrical engineering in 1932 from the South Dakota School of Mines and Technology at Rapid City, S. Dak. During 1933-35, he was with the Wyoming State Highway Department on highway location and inspection. In 1935, he was employed by the Bureau of Reclamation, Heart Mountain Project, at Cody, Wyo., and was transferred to the Bureau's chief engineer's office at Denver, Colo., in 1942. Four years later, he was transferred to the Region 6 office of the Bureau of Reclamation at Billings, where he was head of the Resources and Development Branch of the Power Division. Mr. Lewis was transferred to the head of the Operations and Maintenance Branch in 1959 and was appointed regional supervisor of power in 1960. A registered professional engineer in the State of Montana, Mr. Lewis is a member of the National Society of Professional Engineers, and of the Montana Society of Engineers. He served as chairman of the Billings Subsection, AIEE (1959-60).

Raymond Charles Machler (M '46), director of research and development, Leeds and Northrup Company, Philadelphia, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of electrical measurements." Born February 9, 1906, in Evanston, Ill., he received his B.S. degree in electrical engineering in 1929, his M.S. degree in 1934 in physics, and his Ph.D. degree in physics as a Phi Beta Kappa in 1935, all from Northwestern University. During 1929-32, he worked as a research engineer for Leeds and Northrup. He was employed as a physicist for Leeds and Northrup during 1935-39, was made chief of the Physics Division in 1939, associate director of research in 1948, director of research in 1951, and director of research and development in 1954. He is a member of the company's Management Committee. Dr. Machler was a civilian employee of the Office of Scientific Research and Development in 1944 and received the Naval Ordnance Development Award in 1945. He is a member of the American Physical Society, the American Management Association, the American Association for the Advancement of Science, the American Society for Testing Materials, the Franklin Institute, the Institute of Radio Engineers, the Industrial Research Institute, the National Association of Manufacturers Committee on Research, the Philadelphia Science Council, the Physics Club of Philadelphia, the Society for Applied Spectroscopy, the Spectroscopy Society of Pittsburgh, and Sigma Xi. Dr. Machler has served on the AIEE Electric Heating Committee (1950-52) and Research Committee (1952-57).

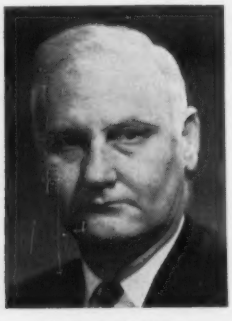
Charles William Maloney (AM '35, M '50), chief electrical engineer, Stone and Webster Engineering Corporation, Boston, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design of electric generating stations and to a major system frequency conversion." He was born December 29, 1898, in Woburn, Mass., and graduated from the Massachusetts Institute of Technology in 1921 with the B.S. degree in electrical engineering. In 1921, he was employed by the City of Boston, assigned to electrical drafting, construction and general engineering. He joined Stone and Webster in 1924 as an electrical designer in the Drafting Division. In 1926, he became an engineer in the Electrical Division and worked on industrial and public utility power plant projects, which included the Rock Island Hydroelectric Development. During 1934-35, he was an electrical engineer for United Engineers and Constructors, Inc. For the following 2 years, he served the U. S. Army Engineers as an electrical engineer in the Eastport, Maine, office, where he developed plans for the Passamaquoddy Tidal Power study. Mr. Maloney returned to Stone and Webster in 1937 as an electrical engineer. For the next 19 years, he was in responsible charge of the electrical engineering on numerous industrial, public utility, and government agency projects. His duties involved determination of unit ratings, planning protective relay schemes, station service supply methods, and selection of switchgear for central station, as well as for transmission and distribution purposes. Among his contributions have been his services in the 50- to 60-cycle frequency change and 25- to 60-cycle frequency change for entire utility systems. He was made assistant chief electrical engineer for Stone and Webster in 1956, and chief electrical engineer in 1957. He is a member of the National Society of Professional Engineers and was chairman of the Boston Section, AIEE (1955-56).

Whitney Matthews (AM '39, M '46), chief of the Payload Systems Division, Goddard Space Flight Center, Greenbelt, Md., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the engineering application of solid-state phenomena and to telemetry systems." Born November 27, 1915, in Crooked Tree, Ohio, he received his B.S. degree in electrical engineering in 1938 from Ohio State University. Mr. Matthews then became associated with the Rural Electrification Administration until called to active duty with the U. S. Marine Corps Reserve in 1942. After serving as a radar officer in training, combat, and research duties, he was released to inactive duty after World War II. Mr. Matthews is now on the retired list with the rank of major. After the war, he joined the staff of the U. S. Naval Research Laboratory in a research program of electronic and solid-state instrumentation techniques. Upon creation of the National Aeronautics and Space Administration in 1958, he was transferred to that organization by Executive Order of the president. Mr. Matthews is a member of the American Association for the Advancement of Science, the Scientific Research Society of America, Tau Beta Pi, and Eta Kappa Nu. He has served on the AIEE Instruments and Measurements Committee (1942-43, 1949-53) and Electronic and High Frequency Instruments Committee (1956-60).

G. A. Lewis

R. C. Machler

C. W. Maloney



Whitney Matthews

Sundbybergs

Robert Nordell

C. E. Pflug

J. A. Rawls

Burndy Corp.

Julian Rogoff

Robert Nordell (M '47), chief engineer, Sieverts Kabelverk, Sundbyberg, Sweden, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and manufacturing of high-voltage cables and for the development of welded aluminum sheaths for cables." He was born May 24, 1907, in Solvesborg, Sweden. In 1933, he graduated from the Royal Institute of Technology, Stockholm, Sweden, and was in the same year employed by the Institute of High Voltage Research, Uppsala, Sweden. He came to Sieverts Kabelverk in 1938 as a research engineer, and in 1949 he was appointed chief engineer of the company. Mr. Nordell has been one of the pioneers in Sweden in developing low- and medium-voltage PVC-insulated power cables to replace paper-insulated cables, and he has made the method of high-frequency resistance welding applicable to aluminum cable sheaths. Since 1951, he has been a member of the Technical Board of the Swedish Bureau for Testing Electrical Equipment (SEMKO), and since 1952, chairman of the official Swedish Cable Standardizing Committee. In 1949, he became an official member of the CIGRE (International Conference on Large Electric Systems) cable committee, and in 1952 he was appointed chairman of Technical Committee No. 33 of the International Electrotechnical Commission. In 1952, he became a special European member of the Insulated Conductors Committee, AIEE.

Charles Evans Pflug (M '50), plant engineer, American Motors Corporation, Kenosha, Wis., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrified production of automobiles." He was born October 22, 1900, in Tobias Village, Nebr., and graduated in 1926 from the University of Nebraska with the B.S. degree in electrical engineering. Mr. Pflug was employed in 1926-28 by the General Electric Company, Schenectady, N. Y., as test engineer and assistant head of testing of large motors and generators. In 1928, he became assistant division engineer of the Wisconsin Power and Light Company. He was engaged as substation engineer for the Wisconsin Gas and Electric Company in 1938. Mr. Pflug began his career with American Motors in 1939, then Nash-Kelvinator Corporation. As electrical engineer, he was responsible for all the power problems, which included industrial equipment and control problems. His principal responsibility became plant engineering. A cargo trailer plant was built and equipped at Racine, Wis.; two propeller plants in Lansing, Mich.; a helicopter plant in Detroit, Mich.; and at Kenosha, Wis., the design and equipment of assembly plants. As plant engineer for American Motors at Kenosha, he took an active part in the building and acquisition program, which increased the plant size from two million square feet to over five million square feet of floor space.

James Ashburn Rawls (AM '31, M '37), manager of engineering and construction, Virginia Electric and Power Company, Richmond, Va., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and operation of electric power systems." Mr. Rawls was born March 22, 1905, at Holland, Va., and graduated in 1926 from the Virginia Polytechnic Institute with the B. S. degree in electrical engineering. Mr. Rawls joined Virginia Electric and Power after graduation, where he was assigned to Suffolk and Norfolk, Va., until his transfer 3 years later to Richmond, Va., the system headquarters. For a 6-month period in 1938, he was loaned by the Baton Rouge Electric Company to organize an engineering department. In Richmond, Mr. Rawls' early assignments pertained to substation and transmission design and construction. In 1947, he was made supervisor of electric equipment and transmission, which included the maintenance and operation of the transmission system, electric equipment, relaying and control, communication, and metering. In 1954, he was made system manager of transmission and distribution, which added the operation of the distribution system to his previous duties. In 1957, he was promoted to his present position in charge of the engineering, planning, construction, and real estate departments. He is a registered professional engineer in Virginia, and a member of the National Society of Professional Engineers, the International Congress on High Voltage Lines, and the Central Virginia Engineers Club. Mr. Rawls has served on the AIEE Transmission and Distribution Committee (1951-61).

Julian Rogoff (M '48), executive vice-president, Burndy Corporation, Norwalk, Conn., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to improvement of electrical connections and to design and development of circuit protective devices." Mr. Rogoff was born May 16, 1910, in New York City, and received the degree of B.S. in mechanical engineering in 1930 from the New York University College of Engineering. Further formal education included graduate work in advanced physics, mathematics, and metallurgy at Polytechnic Institute of Brooklyn. In 1930, he joined Burndy, and moving through a number of design, research, and development positions, he became chief engineer and director in 1947, vice-president in 1955, vice-president and Omaton Division manager in 1956, and executive vice-president in 1960. Mr. Rogoff has developed more than 30 products for which he holds United States patents, as well as several abroad. The products invented include fuses, limiters, other forms of circuit-breaking protection for underground electrical distribution systems, and fusible protection of electric circuits in aircraft. He has directed the research and development concerning electrical connections between copper and aluminum and aluminum to aluminum. His committee work has included the Underwriters' Laboratories Industry Advisory Conference, the Committee on the Preparation of Standards of the National Electrical Manufacturers Association, and the AIEE Committee on the Preparation of the Red Book. Mr. Rogoff is a member of the American Ordnance Association and the History of Science Society, and is a registered professional engineer in the State of New York.

Walter Henry Sammis (AM '20, M '38 Member for Life), president, Ohio Edison Company, Akron, Ohio, has been transferred to the grade of Fellow in the AIEE" . . . for contributions to electric utility engineering, development, and management." Born June 28, 1896, in Hempstead, N. Y., he received the electrical engineering degree in 1917 from Columbia University. Mr. Sammis was an instructor in electrical engineering at Columbia University during 1919-20. He was employed as an engineer for the Consumers Power Company, Jackson, Mich., in 1920-24, and in 1925, he became assistant to the vice-president and general manager. In 1930, he went to the Commonwealth and Southern Corporation as assistant to the vice-president. He became vice-president and director of the corporation in 1938, a position he held until 1941, and was a director in 1942-52. Mr. Sammis has served as a director of the Edison Electric Institute and as its president. He was a vice-president and director

W. H. Sammis

R. W. Samsel

Foto Sport

C. M. Steeves

W. C. Stoker

of the Commonwealth and Southern Corporation in 1933-44, and a director in 1947-49. He was a vice-president and director of the Transportation Securities Corporation in 1933-38 and president and director in 1938-43. During 1932-44, he was a vice-president and director of the Consumers Power Company. Mr. Sammis served as a vice-president and director of the Ohio Edison Company in 1933-36 and 1941-44, and has been its president and director since 1944. He became vice-president and director of the Pennsylvania Power Company, New Castle, Pa., in 1933-36, president and director in 1936-50, and since 1953, chairman of the board. He was a director of the National Association of Electric Companies in 1945-49, a member of the Council of Electric Operating Companies in 1942-45, and a member of the Electric Utility Defense Advisory Council in 1950-53. Mr. Sammis has been a director and executive committee member of the Ohio Valley Electric Corporation and the Indiana-Kentucky Electric Corporation since 1952, a trustee of the East Central Nuclear Group since 1957, and was its president in 1958-59. He is a member of the Executive Committee of the Association of Edison Illuminating Companies, Tau Beta Pi, and Sigma Xi.

Richard Warren Samsel (AM '42, M '49), advance systems engineer, ordnance department, General Electric Company, Pittsfield, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of electro-acoustic and electro-optic gear for submarine defense systems." He was born July 2, 1920, in Evanston, Ill., and was graduated in 1941 from Northwestern University with the degree of B.S. in electrical engineering. That year, he entered the student engineering training program of General Electric and completed the company's Advanced Engineering Program A Course and Nuclear Engineering Course. During 1941-55, he was employed at the General Engineering Laboratory of General Electric. There, he was engaged in the development of high-frequency underwater sound equipment and the electro-acoustic transducers they employ. He was responsible for the General Electric development of barium titanate ceramic transducers. For several years, he worked on noise and vibration reduction problems and contributed several new instrumentation techniques. He did developmental work on high-intensity ultrasonic equipment and consulting in applied physics. From this work in the General Engineering Laboratory, he now holds 13 patents. In 1956, he transferred to the Special Defense Projects Department to work on the Atlas Missile System. In 1957, he was transferred to the ordnance department at Pittsfield. There, he was responsible for the design configuration of the optical alignment subsystem used in the Polaris missile system fire control. He has been in the Advance Engineering Operation since 1959. Mr. Samsel is a member of the Acoustical Society of America and of the Institute of Radio Engineers. He is a member of Tau Beta Pi and Sigma Xi.

Cecil Myron Steeves (AM '29, M '41), technical director, Companhia Brasileira Administradora de Serviços Técnicos, Rio de Janeiro, Brazil, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and operation of a major electric power system in Brazil." Mr. Steeves was born December 16, 1906, in Moncton, N. B., Canada, and received his B.S. degree in electrical engineering in 1927 from the University of New Brunswick. After graduation, he was employed by the Canadian General Electric Company, where he participated in their Graduate Engineers Training Course at Peterborough and Toronto. In 1928, he joined the Brazilian Traction Light and Power group and worked in the engineering department of the Canadian General Finance Company, Toronto, Canada, where he was engaged in engineering and purchasing services for the associated companies in Brazil, Mexico, and Spain. In 1938, he was transferred to the new construction department in São Paulo, Brazil, where he served as electrical engineer in charge of the electrical design, erection, and commissioning of all generating equipment and transmission lines of the Brazilian Traction Companies in Rio de Janeiro and São Paulo. In 1948, he was made chief of the Operating Division of the São Paulo Tramway, Light and Power Company Ltd., and was responsible for system operation and maintenance, as well as station and distribution construction. In 1951, he was transferred to Rio de Janeiro as superintendent of the electrical department of the Rio de Janeiro Tramway, Light and Power Company Ltd., where he was responsible for all the electrical operation of that company. Three years later, he was promoted to assistant general manager in charge of electrical services of the same company. In 1957, he was transferred to the Companhia Brasileira Administradora de Serviços Técnicos, which is the management company of the Brazilian Traction group in Brazil. He is the technical director and acts as a consultant and co-ordinator of electrical engineering matters. Mr. Steeves is a registered professional engineer in the Province of Ontario and is also a member of the Engineering Institute of Canada.

Warren Cady Stoker (M '45), professor of electrical engineering and dean of the Hartford Graduate Division, Rensselaer Polytechnic Institute, East Windsor Hill, Conn., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical engineering education." Dr. Stoker was born on January 30, 1912, in Union Springs, N. Y., and was educated at Rensselaer Polytechnic in Troy, N. Y., from which he received the degrees of electrical engineering in 1933, master of electrical engineering in 1934, and Ph.D. in physics in 1938. Dr. Stoker, who has been a member of the faculty of Rensselaer Polytechnic since 1934, became assistant professor in 1941, associate professor in 1945, and professor of electrical engineering in 1951. During this period, he was actively engaged in research, directing projects in the fields of radio-frequency noise and interference, electromagnetic shielding, and measurements of radiation and leakage. In 1946, he was given responsibility for a new electronics option within the Department of Electrical Engineering. Dr. Stoker was named director of the Computer Laboratory at Rensselaer in 1952, one of the first in the country to provide computer services to industry. He was appointed director of the Hartford Graduate Center of Rensselaer Polytechnic in 1955 and became the dean of this center in 1957. He has served as a consultant to numerous industrial clients. Dr. Stoker is a member of the American Society for Engineering Education, a senior member of the Institute of Radio Engineers, and a member of Sigma Xi, Eta Kappa Nu, and Tau Beta Pi.

Tsen Cha Tsao (AM '41, M '50), senior research engineer, Columbia University Electronics Research Laboratories, New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for rehabilitation of electrical utilities in Greater Shanghai and contributions to

T. C. Tsao

P. G. Wallace

J. B. Ward

A. J. Williams, Jr.

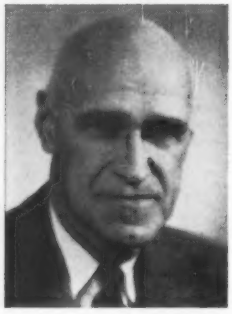
electrical communications." Mr. Tsao was born October 16, 1901, in Shanghai, China. He was graduated with honor in 1924 with the B.S. degree in electrical engineering from the National Chiao-tung University, Shanghai. Mr. Tsao was sent by China to England to receive practical training at the Metropolitan-Vickers Electric Manufacturing Company in Manchester. In 1927, he was admitted to Harvard University, was awarded the M.S. degree in electrical engineering in 1929, and then returned to China to teach at the National Chekiang University. During 1932-39, he was appointed first as project engineer and then as director of the Chekiang Telephone Administration in charge of long distance telephone design, construction, and operation for the whole Province of Chekiang. When the Sino-Japanese war broke out in 1937, he was assigned as the commissioner of telecommunications for Southeastern China and supervised the construction of communication network from Chungking to Shan-Yao for military use. He was the first communications engineer who designed and installed the carrier telephone in China. He was awarded the Medal of Distinguished Service for this assignment by the Chinese National Government. In 1943, he was appointed ministerial director of post and telecommunications for supervising electric communication and post services for entire China. In 1945, when World War II ended, he was appointed commissioner of public utilities for Greater Shanghai. His principal job was the rehabilitation of electric power, telephone, electric tramways, and all other public utilities. He came to the United States in 1949, and in 1950 he joined the Consolidated Edison Company in New York as engineer in system engineering. In 1955, he was an engineer writer and a consultant to McGraw-Hill Book Company in New York. In 1958, he joined the Columbia University Electronics Research Laboratories as senior engineer. His research covers radar and simulators for missile operational training. He is a past chairman of the Chinese Institute of Engineers of Greater New York. He is a licensed professional engineer in the States of New York and New Jersey, a member of the British Institution of Electrical Engineers, a senior member of the Institute of Radio Engineers, a member of the American Society of Mechanical Engineers, a member of the American Rocket Society, and a member of the New York Society of Professional Engineers.

Paul Gipson Wallace (AM '40, M '47), assistant chief engineer, Texas Power and Light Company, Dallas, Texas, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the electrical design and construction of a rapidly expanding electric utility system." He was born January 15, 1903, in Omaha, Texas, and attended Burleson and Texas A & M Colleges. In 1924, he began his engineering career with the Texas Power and Light Company as an electrical draftsman in the engineering department. In 1926, he became a substation section leader in the drafting department where he supervised electrical layouts for 69-kv and 138-kv substations. He was advanced to electrical design engineer in 1929 and to electrical engineer in Trinidad, Texas, in 1933. Two years later, he was transferred to the General Office in Dallas, and worked on the appraisal of the company's electrical property. In 1939, he was appointed head of the Electrical Design Division of the company's engineering department. He was appointed chief electrical engineer in 1951 and assistant chief engineer in 1952. Mr. Wallace is a member of the Texas Society of Professional Engineers, the National Society of Professional Engineers, the Dallas Electric Club, and the Engineers Club of Dallas. He has served as vice-president of AIEE District 15 (1960-62), as an AIEE director (1955-59), and on the following AIEE Committees: Registration of Engineers (1949-51), Transmission and Distribution (1950-61), Edison Medal (1953, 1958), Constitution and Bylaws (1955-57), Safety (1956-57), and Publications Department (1959-60).

James B. Ward (AM '40, M '49), director of research, Pacific Power and Light Company, Portland, Ore., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical engineering through teaching and research." He was born April 27, 1917, in Monte Vista, Colo. After receiving the B. S. degree in electrical engineering at Colorado State University in 1939, he joined the Commonwealth Edison Company. After attending the student training program, he was assigned to the System Development Division for 2 years. In 1942, he joined the faculty of Purdue University in the School of Electrical Engineering. While engaged in teaching and research assignments, he completed work for the degrees of M.S. in 1945 and Ph.D. in 1949, both in electrical engineering. While at Purdue, Dr. Ward worked with a large number of electric utilities on network analyses studies and system analysis problems. Through research activities and supervision of graduate students, he made significant contributions to the literature on loss formulas, economy loading, equivalent circuit, and computer applications to power system problems. In 1957, he joined Pacific Power and Light Company, where he worked on engineering applications of computers and on special studies. In 1959, he was named director of research and placed in charge of Pacific Power's newly formed Research Department. He is a registered professional engineer in Indiana and Oregon and a member of Eta Kappa Nu, Sigma Tau, Phi Kappa Phi, and the American Society for Engineering Education. He has served on the AIEE System Engineering Committee (1950-60).

Albert James Williams, Jr. (AM '27, M '45), science advisor, Leeds & Northrup Company, North Wales, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for his invention, research and development to practice of null-balance system of precise electrical measurement." Born February 28, 1903, in Media, Pa., he received a B.A. degree from Swarthmore College in 1924. Following Summer telephone training in 1923, he started in 1924 with Bell Telephone Laboratories, assigned to designing transformers. Starting with the Leeds and Northrup Company in 1927, he joined the research department in 1929 with an assignment on recorders. His work led to deliveries in 1933 of null-balanced recorders improved by the use of a d-c to a-c modulator, vacuum tubes, and a reversible motor with tachometer damping. During 1934-51, he was chief of the electrical division of the research department and provided ideas and leadership resulting in the solution of a great many problems which involved electrical measurements. In 1951, he became associate director of research, and since 1955 has been science advisor to make greater use of his technical talent. Some of his work is on record in 38 U. S. patents and in technical papers, 7 on recorders, 4 on amplifiers, 3 on measurements, and 1 on golf. He is a member of Sigma Xi, the American Physical Society, the American Society of Mechanical Engineers, and a Fellow of the Institute of Radio Engineers. He has served as a liaison representative on standards (1951-54) and on the following AIEE Committees: Research (1936-40), Standards (1949-50), and Feedback Control Systems (1949-56).

AIEE PERSONALITIES



R. D. Bennett

R. D. Bennett (F '35) has joined the staff of the Martin Company, Baltimore, Md., in the newly created position of director of research. Dr. Bennett was formerly associated with the General Electric Company, where he was manager of its Vallecitos Atomic Laboratory at Pleasanton, Calif. He has served on the AIEE Nucleonics Committee (1957-61).

T. B. Collins, Jr. (AM '54) has been appointed product engineering manager in the commercial marketing departm.ent of Lenkurt Electric Company, Inc., San Carlos, Calif. Formerly director of Carrier and Radio Sales for Automatic Electric Sales Corporation, Chicago, Ill., Mr. Collins will be responsible in his new position for the technical liaison necessary between marketing and development engineering. Mr. Collins succeeds **M. C. Royalty** (AM '36), who has been named Southwestern District sales manager, with offices in Dallas, Texas.

M. A. de Ferranti (M '43) has been appointed president of ITT (International Telephone and Telegraph Corporation) Europe, Inc., and European general manager. He joined ITT from the International Group of General Electric Company, where he was most recently on special international assignment for the company. As head of ITT Europe, Mr. de Ferranti will make his headquarters in Brussels, Belgium, where he directs the co-ordination and expansion of ITT's extensive investment in manufacturing, sales, service, and telecommunications operations throughout Europe, Africa, and the Middle East.

H. S. Eadie (M '60) has been elected vice-president and general manager of the Grigsby Company, Inc., Arlington Heights, Ill. He joined Grigsby in 1958.

Harold Goldberg (AM '35, M '44), formerly vice-president in charge of Emerson Research Laboratories, has been named executive vice-president of Emertron, Inc. The Board of Directors of Emertron includes Dr. Goldberg and **D. D. Israel** (F '48), executive vice-president, Emerson Radio & Phonograph Corporation, Jersey City, N. J.

F. W. Gutzwiller (AM '51) has been appointed manager of application engineering for the General Electric Rectifier Components Department, Auburn, N. Y. He was previously consulting engineer for rectifier applications. Mr. Gutzwiller is in charge of developing new and broader uses for semiconductor rectifier components as well as assisting customers in solving specific application problems.

R. T. Horsfall (M '48), formerly chief engineer of the W. W. Clark Corporation, Cleveland, Ohio, has been elected vice-president in charge of engineering.

A. C. Keller (AM '47, M '50), director, Switching Systems Division, Bell Telephone Laboratories, Inc., New York, N. Y., has been named a Fellow of the Institute of Radio Engineers. He was cited "for contributions to the recording and reproduction of stereophonic sound and to telephone switching."

N. O. Kirkby (AM '58) has been appointed vice-president of the G&W Electric Specialty Company, Blue Island, Ill.

F. D. McCann (Affil '56) has been appointed manager of the New York Industrial Sales Office of General Precision, Inc., Kearfott Division. Mr. McCann was formerly a representative for Kearfott power equipment and ultrasonic products.

R. L. McDermott (AM '51) has been appointed manager of industrial sales of the Norwood, Ohio, Works of the Allis-Chalmers Manufacturing Company. He was formerly manager of general industrial sales in the Cincinnati district.

R. J. Palmer (AM '22, M '46, Member for Life) has retired as municipal lighting engineering co-ordinator for the Detroit Edison Company, Detroit, Mich., after almost 39 years of service with the company. As a lighting engineer, Mr. Palmer was responsible for the design of street lighting systems for several communities, which include Highland Park, Grosse Pointe, Harper Woods, Dearborn, River Rouge, and Ferndale. Mr. Palmer started with Detroit Edison in 1922 as a surveyor with an electric power line construction crew in the Ann Arbor area and held several posts in the company's engineering departments before being named municipal lighting engineering co-ordinator for the general engineering department in 1954.

A. E. Rosenberg (AM '47, M '55) has been appointed operations manager for the Components Division of Epsco, Inc., Cambridge, Mass. Mr. Rosenberg came to Epsco from the Raytheon Company where he was engineering manager, Circuit Pak Department.

J. A. Smith (AM '44, M '53), formerly assistant vice-president, has become vice-president, production and power operations, Shawinigan Water and Power Company, Montreal, Que., Canada. **Donald King** (AM '38, M '49), formerly assist-

Cooper Union Medal Presented

L. W. COLE (M '43), chairman of the board of Federal Pacific Electric Company (*center*), received the Cooper Union Alumni Association's Gano Dunn Medal for Professional Achievement at a Founder's Day banquet held February 11 by the Cooper Union Alumni Association. M. M. Becker (M '58), Class of 1921, Cooper Union School of Engineering, and president of the Standard Switchboard Corporation (*left*), presented the medal. I. S. Olds (*right*) is chairman of the Cooper Union Trustees and former chairman of the board of the U. S. Steel Company.

ant manager, power operations and engineering department, has become vice-president, in charge of a new department to be called the system planning and engineering department, which has been established to co-ordinate these functions. Mr. Smith has served on the AIEE Power Generation Committee (1960-61). Mr. King is a member of the AIEE System Engineering Committee (1958-61), and District 10 representative to the Technical Operations Department (1960-61).

G.M. Stapleton (M '44), vice-president of Ward Leonard Electric Company, Mount Vernon, N. Y., has been appointed general manager of the company and will continue as manager of dimmer sales.

W. G. Stiffler, Jr. (AM '59), has joined the Reliance Electric and Engineering Company as senior insulation engineer at the company headquarters in Cleveland, Ohio. Mr. Stiffler will direct the engineering and development activities which involve electrical insulation for all of the company's products which include electric motors, gearmotors, electrical and mechanical speed drives, electronic and magnetic controls and regulators for industrial and marine purposes.

B. J. Stimpson (AM '52) has been promoted to the position of marketing manager—power circuit breakers and power switching equipment for Federal Pacific Electric Company, Newark, N. J. Subsequent to his appointment to marketing manager, he was assistant marketing manager—circuit breakers and power switching equipment.

B. M. Werly (AM '25, F '51), assistant manager of the engineering, construction, maintenance, and utilities organization of the Kodak Park Works of Eastman Kodak Company, Rochester, N. Y., will become manager of the organization on June 1.

J. B. Williams (AM '43, M '52), vice-president of Electronic Communications, Inc., and general manager of its St. Petersburg Division, was elected a director at the annual meeting of stockholders. He joined the corporation in 1960.

M. A. Xavier (AM '53) has been elected vice-president of Century Electronics & Instruments, Inc., Tulsa, Okla. As chief engineer of the firm, Dr. Xavier spearheaded the design and engineering groups who are successfully completing the first phase of the Minuteman Telemetry Car program under subcontract to Boeing Aircraft Company.

M. M. York (AM '43, M '54) has been appointed director of industry co-ordination for the Industries Group of Allis-Chalmers Manufacturing Company, Milwaukee, Wis. In his new capacity, Mr. York is responsible for continuing the development of industry contacts and promotion for the purpose of accomplishing a better understanding of company capabilities and industry needs. He was previously manager of marketing for the Industrial Equipment Division

W. F. Young (M '36) has retired as executive vice-president of G&W Electric Specialty Company but remains in an advisory capacity.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

OBITUARIES

Frank Cleveland Bolton (AM '09, M '14, F '42, Member for Life), president emeritus of Texas Agricultural and Mechanical (A & M) college, died January 31 at the age of 77. Since his retirement, Dr. Bolton had been an electrical engineering consultant to industry in the Southwest. He was also a director of various state programs in the application of electricity to agriculture. Born March 24, 1883, in Pontotoc, Miss., he received the B.S. degree in electrical engineering from Mississippi State College in 1905, and the M.S. degree from Ohio State University in 1928. The honorary degree of LL.D. was conferred on him by Austin College in 1932. He was an instructor at Mississippi State College during 1906-09, and in 1909 he joined the Texas A & M faculty as a professor of engineering. He served as head of the department of engineering, dean of engineering, dean of the college, executive vice-president, and then president, until his retirement in 1955. Dr. Bolton served as vice-president of AIEE District 7 (1938-40) and on the following AIEE Committees: Education (1936-41), Membership (1938-39), Board of Directors (1938-40), Legislation Affecting the Engineering Profession (1940-41), and Institute Policy (1941-42).

William Henry Fisher (AM '54, M '56), chief electrical engineer for the California-Oregon Power Company, died January 18. He was born in Scottsburg, Ore., on July 28, 1911, and was a graduate of Oregon State College with the B.S. degree in electrical engineering. He was employed by the company after graduation. His duties were interrupted by military service during 1942-45, when he served in the U. S. Navy as a lieutenant in the Mediterranean, European, and Asiatic theaters of operation.

Lyde E. Howard (AM '40, M '47), manager of engineering, wire and cable department, General Electric Company, Bridgeport, Conn., died January 14. Born January 28, 1909, in Cairo, Ill., he received the B.S. in electrical engineering in 1930 from the University of Missouri. Mr. Howard was employed by General Electric in Schenectady, N. Y., in 1930, assigned to testing electric equipment. In 1932, he was transferred to cable design engineering. In 1937, he became cable specialist, in Chicago, Ill., in charge of the application and sale of power cable systems. Two years later, he was transferred to Philadelphia, Pa., as district cable specialist. Mr. Howard served on the AIEE Insulated Conductors Committee (1953-61).

E. Donald Kennedy (AM '32, M '49), electronics engineer, Harshaw Chemical Company, Cleveland, Ohio, died March 6 at the age of 52. Mr. Kennedy had been associated with Harshaw for the last 7 years. Previously, he worked for Goodyear Aircraft Corporation in Akron, Ohio, and was a professor of electrical engineering at the University of Florida. Mr. Kennedy was born in Tangsi, China, on November 11, 1908. He graduated from Case Institute of Technology in 1930 with the B.S. degree in electrical engineering, and in 1933 from Rutgers University with the M.S. degree in communications. He was a member of the Institute of Radio Engineers.

Roy Eric Lindblom (AM '26, M '35), electrical engineering professor, University of Washington, Seattle, Wash., died January 2. Born October 19, 1898, in Minneapolis, Minn., he was educated at the University of Washington from which he received the B.S. and M.S. degrees in electrical engineering in 1922 and 1929, respectively. In 1922, he was employed by Boeing Airplane Company in Seattle, Wash., and the following year by Stone and Webster, Seattle. In 1924, he joined the Department of Electrical Engineering at the University of Washington as an instructor. He was advanced to assistant professor in 1929, and to professor in 1945. Prof. Lindblom was primarily responsible for the design of the present Electrical Engineering Building, constructed in 1948, and supervised the laboratory installations throughout the building. He was a licensed engineer in the State of Washington.

Carl Russell (AM '43, M '48), electrical engineer, Pacific Power and Light Company, Portland, Ore., died February 3 at the age of 61. Mr. Russell was born in Sweet Home, Ore., on July 2, 1899. He graduated from Oregon State College in 1921 with the B.S. degree in electrical engineering. Mr. Russell joined the company in 1946 as division engineer in Astoria, Ore. In 1949, he was transferred to Portland as assistant area engineer, the position he held at the time of his death. Mr. Russell was a registered professional engineer in the State of Oregon and a member of the Professional Engineers of Oregon and the National Society of Professional Engineers.

Roy E. Uptegraff, Sr. (M '45), an electrical engineer and chairman of the Board of R. E. Uptegraff Manufacturing Company, Scottdale, Pa., died February 1. Born June 13, 1888, in Kansas, Mr. Uptegraff began manufacturing electrical transformers in Pittsburgh, Pa., in 1925. He started with $750 working capital, and by 1929 the company was beginning to round out its product line. In 1939, the company moved to Scottdale. He recently helped establish the company's subsidiary, the Uptegraff Transformer Company in Somerset, Pa.

OF CURRENT INTEREST

TINY TRANSMITTER demonstrated by International Rectifier Corporation's research chimpanzee Murph and engineer Harvey Hanish is part of company's new ground monitoring equipment for checking heart conditions of astronauts in space. Electrodes taped on chimp's chest transmit heart data instantly from out in space; information is continuously recorded on oscilloscope.

Space-Age Chimps Demonstrate Bioelectronic Devices

UNITED STATES space research is already paying off in new devices capable of helping medical science save and prolong life here on earth.

These devices, premiered recently by International Rectifier Corporation, El Segundo, Calif., permit doctors and surgeons to watch and listen to the heart, brain, and other vital organs through miniature electronic "windows" and tiny microphones.

Two space-age chimpanzees, Murph and Jerry, recently demonstrated how the "bioelectronic" units are based to check and report on the whole human physiological system of men in space or men on earth. The scientific simians were flown from California to demonstrate the equipment, which included the types used by their "cousin," Ham, in the first United States chimpanzee-manned space flight.

Dr. Oscar Dallons, head of International Rectifier Corporation's Dallons Laboratories, Inc., subsidiary, disclosed that such devices are essential in assisting space and medical scientists and gathering data on heart, lung, and brain response to weightlessness and other environmental factors that the first astronauts will experience. He also revealed that the company's bioelectronic equipment is being placed in modern hospitals, clinics, and laboratories, greatly advancing conventional methods and shortening precious diagnosis time.

For example, Dr. Dallons said, one device makes it possible for physicians and surgeons to make an accurate diagnosis of a cardiac emergency within 3 minutes after a patient enters a hospital, where conventional methods require several hours.

Medical and electronic space experts call these devices "physiotel" equipment, short for physiological telemetry—the measurement and transmission of physiological data from space to earth, or over any distance.

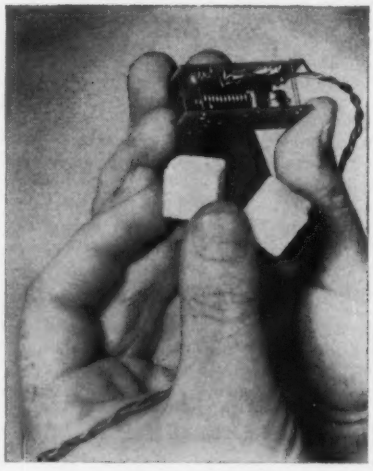
Advanced devices disclosed by International Rectifier Corporation were:

1. A microphone, called a micromanometer, so tiny it can pass through the eye of a sailmaker's needle. The "mike" is inserted through the arteries into the heart and reports with 5,000-cycle fidelity the condition of the heart from the inside out via a coaxial cable.

2. A sugar-cube-size "hewline" ("Hospital Early Warning") cardiac monitor that, used in conjunction with an electrode chest belt, can give a physician an accurate electronic report on a patient's heart, eventually by local or long-distance telephone.

3. A similar monitor that can be used aboard a space capsule or at earth monitoring stations to help transmit readings on human physiological responses via radio telemetry, or for tape recordings either aboard a space vehicle or on earth.

4. Electronic monitors in use and available to medical science that give cardiac specialists instant and accurate readings on an astronaut's condition, or in operating or emergency rooms, on a patient's immediate heart beat, pulse, temperature, and brain waves. **EE**



CUBE-SIZE transmitter, developed by International Rectifier Corporation's Dallons Laboratories to monitor hearts of astronauts in space, can also save lives on earth by reporting heart conditions to physicians by telephone to save precious time.

Airborne TV System To Help Guide Telescope Floating in Stratosphere

A NEW and complex high-altitude airborne television system, nearing completion at the laboratories of the Radio Corporation of America (RCA), will provide astronomers with remote electronic "eyes" as they study the heavens through a 36-inch telescope suspended from a balloon 15 miles above the earth.

The balloon telescope project, known as Stratoscope II, was conceived by Prof. Martin Schwarzschild, of the Princeton University Department of Astronomy. It is now in preparation by Princeton University under joint sponsorship of the Office of Naval Research and the National Science Foundation. The National Aeronautics and Space Administration is supporting the television development.

RCA is providing for the system a television complex that will enable astronomers on the ground to select fields of view for the telescope through television cameras on the balloon-borne assembly, and a remote-control communications system that will transmit commands aloft from the base station.

Details of the new television system were disclosed by L. E. Flory, who headed an RCA Laboratories engineering team under the general supervision of Dr. V. K. Zworykin, honorary vice-president of RCA, in developing the equipment at the David Sarnoff Research Center, Princeton, N. J. The same team developed a smaller television system used successfully in 1959 to help in guiding a 12-inch telescope carried aloft in the Stratoscope I project for studies of the sun.

The Stratoscope I project resulted in the clearest sequence of photographs ever recorded of the surface of the sun and the areas immediately surrounding sunspots. With Stratoscope II, Princeton University astronomers hope to gain a clearer understanding of such phenomena as the divisions in Saturn's rings, the sudden atmospheric changes that take place on Jupiter and Venus, and the gaseous nebulae from which new stars are formed.

According to Mr. Flory, the RCA system for Stratoscope II represents "a major advance in the application of television to the special requirements of astronomy." He gave the following description of its principal features:

Two specially developed transistorized television cameras, each weighing about 58 pounds, will be mounted in pressurized cylinders on the telescope assembly suspended from the balloon. One of the cameras, equipped with a wide-angle lens, will look directly out into space. Scanning an area extending across 10 degrees of the sky, it will transmit to the ground a large-area picture to be used by the astronomers in selecting their targets for detailed viewing through the telescope.

The second camera will be positioned to look through the telescope to show the astronomers what the instrument is seeing. This magnified smaller-area image, covering less then 1 degree of the sky, will guide the astronomers in centering the telescope on the stars, star clusters, or planets which are to be studied in detail and photographed with a film camera included in the airborne assembly.

At the heart of each camera is a new developmental RCA image orthicon pickup tube so sensitive that it can "see" stars too faint to be seen by the naked eye. Developed jointly by RCA Laboratories and the RCA Electron Tube Division at Lancaster, Pa., the new tubes resemble the standard image orthicon tubes used in conventional television studio cameras, but have a more efficient cathode and a newly developed semiconductor target. These features provide an image orthicon tube that is particularly suited for use at the extremely low light levels involved in astronomy, and, at these very low light levels, the tube has at least ten times the sensitivity of a standard image orthicon.

According to Mr. Flory, the Stratoscope II cameras have picked up and transmitted images of eight-magnitude stars in outdoor tests at RCA Laboratories. He added that stars as faint as the twelfth magnitude should be visible to the camera which looks through the 36-inch telescope. By comparison, the normal human eye cannot see any object fainter than a sixty-magnitude star even under the most ideal viewing conditions.

In addition to the special pickup tubes and fully transistorized circuits, the new cameras are equipped with remote controls which will enable ground operators to adjust all of their essential functions during flight. It was pointed out that the degree of control permitted by the system will be "nearly as complete as that given to the cameraman in a conventional television broadcast studio."

Besides the new cameras and their associated airborne transmitters and ground-based monitors, RCA Laboratories engineers have developed a multifunction antenna system which will be mounted on the telescope assembly to handle all communications between the balloon and the base station. To relay operating instructions to the balloon from the ground, two special 20-channel command radio systems have been developed by RCA's Astro-Electronics Division, Princeton, employing techniques similar to those used for remote control of operations in the RCA-developed Tiros weather observation satellite.

The engineering team responsible for development of the television system includes W. S. Pike, J. M. Morgan, L. A. Boyer, and A. D. Cope, who directed the RCA Laboratories work on the special Image Orthicon tubes. The antenna system was developed by O. M. Woodward, of the RCA Laboratories technical staff.

EE

A new type of transistorized television camera, one of two to be sent aloft on the Stratoscope II 36-inch balloon-borne telescope for astronomical studies from an altitude of 15 miles, is shown here receiving adjustments by L. A. Boyer at RCA's David Sarnoff Research Center, where the cameras and their associated transmitting and receiving systems have been developed. At right is lens through which camera will scan the heavens to provide astronomers on ground with image needed for remote control of telescope's aim.

Secret Communication System Uses Infrared Radiation Gun

A new communication system that uses "ray guns" to transmit voices secretly and silently by means of invisible infrared beams has been announced by the Aeronautical Division of Minneapolis-Honeywell.

The system makes use of sending and receiving units shaped like guns. They are

WORDS spoken into device are electronically converted into infrared beams and transmitted to a similar gun-like receiver several miles away that converts the message back to sound. The system, called MAXSECOM (Maximum Security Communications) was developed by Minneapolis-Honeywell for use in military, police and civil defense operations, and for a variety of industrial applications.

aimed at each other for the transmission of a narrow beam of infrared radiation. Words spoken into the gun are electronically converted into infrared beams and transmitted to the receiver which converts the message back into sound.

Small hand-held units can be used for communication between points up to 3 miles apart, and there are larger systems that have a range of up to 20 miles.

The system, called MAXSECOM (Maximum Security Communications), is described as immune to interference, detection, or jamming. It was developed for military, police, and civil defense applications, and for a variety of industrial applications.

It was pointed out that since the system requires no wires or cables between transmitting and receiving units, it can be put into operation quickly as a temporary communication system. Also termed an advantage is the fact that it uses a portion of the electromagnetic spectrum that is considerably less crowded and, therefore, less subject to public control than radio channels.

The infrared signal of MAXSECOM is confined by optical control to a narrow beam between sender and receiver. The signal can be received only in this zone, and then only by another MAXSECOM unit containing the necessary specialized infrared sensor optics and decoding device.

The optical assembly for MAXSECOM consists of a lamp housing, condensing lens system, germanium semiconductor modulator crystal, lead sulfide detector, and collecting optics. Weight of the entire transceiver unit is under 10 pounds.

Here is how the system works: Infrared radiation is emitted by a tungsten filament lamp, collected by the condensing lens system, and focusd onto the face of the semiconductor modulator. Voice signals picked up by a microphone are amplified and impressed on the modulator.

Electrical modulation of the crystal results in an optical modulation of the incident infrared radiation as it passes through the crystal. The outgoing infrared radiation is collected on the lens and refracted into a narrow cone of radiation.

At the receiving end, a MAXSECOM unit collects the modulated infrared radiation and focuses it onto the detector cell. The signal then is amplified by means of the same electric circuits used for transmission, and the signals are sent into the speaker. **EE**

Nuclear-Thermoelectric Generator Developed

A new lightweight nuclear generator which converts heat directly into electric power is undergoing performance testing at the Air Research and Development Command's Air Force Special Weapons Center in Albuquerque, N. Mex. It was developed under Air Force contract to provide a reliable and long-life power source for facilities such as small unmanned surface radio beacons and weather stations. The completely portable nuclear auxiliary power device, which weighs less than 40 pounds, was designed and constructed by the new products laboratories of Westinghouse Electric Corporation in Pittsburgh, Pa. The generator produces approximately 150 watts of electric power and was designed for 1 year of continuous unattended operation. It uses radioactive isotopes, such as Curium 242 as its heat source.

The generator's 144 small semiconductive elements are heated by this heat source to a temperature of about 1,000 F. Finned heat exchangers, which cover the generator like the quills on a porcupine, keep the cold side of the elements at a temperature of 300 F. This temperature difference produces a flow of electric current in the elements. The over-all device is only 10 inches high and 16 inches in diameter.

Designated the *NAP-100*, it is another step in a series of developments by the Air Research and Development Command which will lead to increasing Air Force utilization of thermoelectric devices for converting nuclear energy directly into electric power. Such devices are dependable and durable. They have no movable parts, are easy to install and require a minimum of maintenance.

The Air Force Special Weapons Center's Nuclear Power Applications Branch is conducting environmental, endurance, efficiency, and maximum power testing under the direction of Captain Gerald McGovern of Washington, D.C.

The thermoelectric couples used in the generator were fabricated at the Westinghouse semiconductor department plant at Youngwood, Pa. **EE**

Computer Designed Especially For Automatic Programming

A new solid-state electronic information processing system—a self-regulating problem-oriented data-processing system that makes flexible multiprocessing and system expansion without reprogramming practical for the first time—has been announced by Burroughs Corporation.

Departing from traditional concepts of electronic computer design, the system, called the *B5000*, is the first computer designed especially for automatic programming.

R. R. Eppert, Burroughs president, said the medium-priced system will provide large-scale performance for both business and scientific problems "with an ease of operation some computer experts predicted would not be forthcoming for another decade.

"The *B5000* is a computer user's computer," he said, "because it abandons the piecemeal approaches of conventional machines to attack the total problem-solving process—from problem analysis and statement through programming, debugging and processing to final results."

"Computer engineering technology in providing high internal machine speeds far outstripped the ability to use this speed efficiently. And every time the speed was increased it became even more difficult to communicate with the computer."

The *B5000*, like other large-scale electronics systems, is fast (execution time for the add operation is 3 microseconds or more than 250,000 additions per second), but Burroughs designers have found a way to use this speed efficiently and close the communications gap at the same time, it was stated.

The result is a problem-oriented system, operating in common algebraic and business languages, so that high-speed computations need no longer be preceded by painfully slow computer programming, problem translation, and debugging.

A complete "software" package, including ALGOL (Algorithmic Language) and COBOL (Common Business Oriented Language) compilers, as well as powerful extensions of each, and a comprehensive master control program, will be standard with each system.

This will enable users to communicate efficiently with the machine in the language of the problem, both for initial programming and subsequent symbolic debugging, rather than in complex numerical codes. Efficient object machine language programs will be compiled automatically 20 to 50 times faster than the most advanced automatic programming techniques employed thus far on conventional computers.

The master control program will permit maximum, efficient operation with

► **SIMPLE examples of the two universal automatic computer programming languages, ALGOL (Algorithmic Language) and COBOL (Common Business Oriented Language), show how closely they resemble their pure derivatives, algebra and English. Both ALGOL and COBOL will be standard on the Burroughs B5000 Information Processing System.**

mathematical problem:	*data processing problem:*
d=a(b+c)	FICA DEDUCTION = FICA RATE (GROSS PAY+RAISE)
ALGOL statement:	*COBOL statement:*
D := A x (B+C);	COMPUTE FICA-DED EQUALS FICA-RATE TIMES (GROSS-PAY PLUS RAISE)

minimum human intervention. Virtually self-regulating, the system schedules and keeps track of its own workload, automatically by-passes certain units if they malfunction, and advises its operator when he makes a mistake.

The computer automatically performs diagnostic maintenance routines to assure maximum up-time, either during processing or at the conclusion of all processing.

ALGOL–COBOL Spoken Here

Development of two common computer languages, ALGOL and COBOL, is enabling man to talk to these intricate electronic machines in algebra and English.

ALGOL, formulated in 1958 by an international group of logicians, mathematicians, and computer experts, allows computer commands to be expressed in nearly pure algebra, the mathematician's natural problem-solving language. COBOL, now under development, is designed as a common language for business data processing.

In the past, computer instruction (programming) was a ponderous task, requiring knowledge of complex numerical machine codes, foreign to all but the highly trained specialist. The writing of one program often tied up teams of high-priced talent for many months. Resulting costs, in many cases, rivalled the price of the equipment complex itself.

Programming in familiar algreba (ALGOL) and English (COBOL) substantially reduces the time necessary to do the job, releasing persons of advanced talents and training for more demanding assignments. Practical use of these automatic programming languages also is expected to increase computer acceptance among those who have to date been reluctant to assume the huge programming expenses previously necessary.

Burroughs, the first manufacturer to implement the use of ALGOL in communicating with a computer, drew from its experience with common languages in designing the *B5000*. **EE**

"Hypalon" Synthetic Rubber Key to A-C Powered Mining Operation

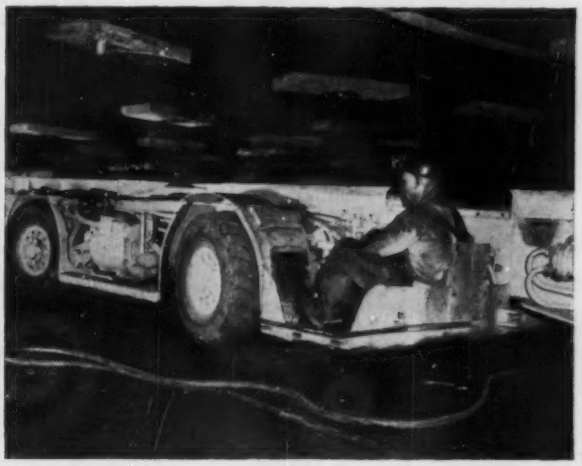
DEEP in the Warrior coal fields, 380 feet below the wooded Allegheny foothills northwest of Birmingham, Ala., "Hypalon" synthetic rubber is playing a key role in the electrical system of one of the first coal mines in the United States to use alternating current throughout the installation.

The mine, SEGCO Mine No. 1, operated by Alabama By-Products Corporation as agents for the Southern Electric Generating Company, produces bituminous coal for a steam-powered electric generating plant. Alternating current was specified for the installation to gain economies both in initial installation and in operations and maintenance.

The higher voltages used in a-c installations underground required exceptionally high standards in equipment reliability to guard against personal injury or costly interruptions in production. While adequate cable, switchgear, transformers, and safety controls were readily available, high-voltage connectors capable of meeting mining requirements posed a major problem. Because the connectors are used not only where cable lengths meet but also wherever the circuits enter or leave control and transformer boxes or operating equipment, solution of the problem was fundamental in developing a safe, workable system.

Five years of research, development, and exhaustive testing by the Electrical Products Division of Joy Manufacturing Company in St. Louis were required to produce a satisfactory unit. A major problem was the fact that none of the elastomers tested could stand up to the rugged requirements.

Then Joy engineers turned to a relatively new elastomer—Hypalon synthetic rubber—noted for resistance to ozone, corona, weathering, and abrasion. The result was a rugged connector permanently vulcanized to the cable jacket, rated for 7,500 volts. The body of Hypalon, a chlorosulfonated polyethylene developed by Du Pont, stood up to all



ABOVE, LEFT: High-voltage connector of Hypalon synthetic rubber on mine cable is rated for 7,500 volts. Lock, safety caps assure safety in use or disconnected. *Above, right:* Shuttle car operates on a-c system made possible through use of high-voltage connectors of Hypalon, increasing operating efficiency. Hypalon, a chlorosulfonated polyethylene, was developed by Du Pont.

Future Meetings of Other Societies

Institute of Radio Engineers

Fifth Midwest Symposium on Circuit Theory, May 6-9, University of Illinois, Urbana, Ill.

13th Annual National Aerospace Electronics Conference, May 8-10, Biltmore and Miami Hotels, Dayton, Ohio.

National Symposium on Microwave Theory and Techniques, May 15-17, Sheraton Park Hotel, Washington, D.C.

AIChE, National Meeting, May 7-10, Cleveland, Ohio. J. F. Antwerpen, Secretary, American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N.Y.

SMPTE, 89th Semiannual Convention, May 7-12, King Edward Sheraton Hotel, Toronto, Ont., Canada. Society of Motion Picture and Television Engineers, 55 W. 42nd St., New York 36, N.Y.

American Foundryman's Society, 65th Castings Congress and Exposition, May 8-12, Brooks Hall, San Francisco, Calif. Denham & Co., 925 Book Building, Detroit 26, Mich.

15th Annual Power Sources Conference, May 9-11, Shelburne Hotel, Atlantic City, N.J. Power Sources Div., U. S. Army Signal Res. & Dev. Lab., Fort Monmouth, N.J.

American Institute of Industrial Engineers, Annual National Conference and Convention, May 11-13, Sheraton Cadillac Hotel, Detroit, Mich. James E. McCartney, 12th Annual AIIE Conf., Rm. 29, 4181 Oakman Blvd., Detroit 4, Mich.

American Society of Mechanical Engineers, Design Engineering Show, May 22-25, Cobo Hall, Detroit, Mich. Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

Symposium on Large-Capacity Memory Techniques for Computing Systems, May 23-25, Dept. of Interior Auditorium, Washington, D.C. Miss J. Leno, Code 430A, Office of Naval Rseearch, Washington 25, D.C.

7th Annual Radar Symposium, May 31-June 2, University of Michigan, Ann Arbor, Mich. Co-ordinator, 7th Annual Radar Symposium, Institute of Science & Technology, Box 618, Ann Arbor, Mich.

Overseas

1st International Television Festival, May 15-27, Montreux, Switzerland. Mark Associates International, 501 Madison Ave., New York 22, N.Y.

IMEKO Conference, June 26-July 1, Engineering Societies Building, Budapest, Hungary. J. Johnston, Jr., President of ISSA, Dupont de Nemours, Wilmington 98, Del. or IMEKO Secretariat, Budapest 5, P.O.B. 3.

United Nations Conference on New Sources of Energy, Aug. 21-31, Rome, Italy. A. G. Katzin, Executive Secretary, United Nations Conference on New Sources of Energy, United Nations, New York, N.Y.

Rassegna Internazionale Elettronica, Industrial and Commercial Exhibit, Aug. 21-31. Via della Scrofa 15, Rome. (Organized by "Rassegna"—not United Nations or the Italian Government). Same.

Third International Conference on Analog Computation, Sept. 4-9, Belgrade, Yugoslavia. Yugoslavia Committee for ETAN, Terazije 23/VII, Belgrade, Yugoslavia.

tests, proving superior even to a 2-stage molding made with two synthetic rubbers noted for resistance to corona. The connectors have been in use in SEGCO Mine No. 1 for over a year and have shown outstanding resistance to abrasion, moisture, and aging.

As fitted for mine power cable, the unit provides connection for three conductors, plus pilot and ground check conductors. Cast manganese bronze couplings are equipped with slotted flanges which can be padlocked together to prevent accidental or unauthorized disconnects. Matching receptacles are provided for use on equipment boxes. Locking protective caps are supplied with all units to insure safety and cleanliness when disconnected. High-voltage connectors can also be provided for types *W, G, SH-A, SH-B, SH-C,* and *SH-D* cable, for use in all types of high-voltage industrial and mining installations.

The importance of the connectors is underlined by their extensive use throughout the electrical system of the SEGCO mine. Depending on the number of lengths of 500-foot cable in use to reach the working mine face, as many as 40 connectors may be required for one working unit.

Unlike d-c operations, where high voltage is not carried beyond the standard rectifier set, rotary converter, or motor generator, the a-c installation carries high voltages well into the underground mine entries. Power reaches the mine through a 1,000-kva transformer, which reduces voltage from 12,400 to 4,160 volts. A permanent cable is carried down approximately 380 feet through the bore hole, where a field splice carries it to an interrupting switch. From there, 500-foot lengths of 4/0 3-conductor cable rated at 5,000 volts are used up to a gang box for breakdown into individual circuits and thence to portable switch houses. From each switch house, 500-foot No. 1 3-conductor cable lengths go to a 300-kva transformer, where the voltage is transformed to 440 volts.

The lower voltage circuits are carried through a safety circuit center and two face distribution centers. Each of the face distribution units carries three or four trailing cables which power cutters, loaders, shuttle cars, and other face equipment. In addition, underground substations provide power for an underground crusher, and a conveyor belt system 2 miles long at present but scheduled to expand to 4 miles as the mine extends operations.

SEGCO Mine No. 1 began operating in September 1959, with three units. A fourth unit was added in March 1960, and a fifth in May. With further additions the mine is now running 16 shift-units per day to bring production up to 6,500 tons a day.

In addition to the Hypalon synthetic rubber used for the connectors, another synthetic rubber, neoprene, is performing yeoman service in the mine. Both elastomers have excellent resistance to flame, particularly important in preventing spread of a blaze along conveyor belts and electric cables. Coal is carried in the mine exclusively by conveyor belt once it leaves the shuttle cars which carry it from the face itself. Every foot in the 2-mile network of 36-inch side belts and 42-inch main belt is of sturdy neoprene construction. These belts convey the coal to a lower level crushing plant, from which it is belt-carried 1,900 feet up the slope for washing and loading on railroad cars. In addition, neoprene cable jacketing is used throughout the mine. **EE**

Full-Scale Model of Surveyor Spacecraft Unveiled

FOUR cameras aboard the Surveyor spacecraft will send television pictures of the moon's surface back to earth, each camera transmitting pictures at the rate of one every few seconds.

These and other details about the lunar soft-landing spacecraft were revealed by engineers of the California Institute of Technology Jet Propulsion Laboratory (JPL) and the Hughes Aircraft Company, Culver City, Calif., as a full-scale model of Surveyor was unveiled at JPL.

Dr. T. K. Glennan, former administrator of the National Aeronautics and Space Administration (NASA), last January 19 announced in Washington the selection of the Hughes Company for contract negotiations to build Surveyor.

Plans call for seven Surveyors to be launched to the moon in the period 1963-65. JPL, NASA's center for lunar and planetary exploration, will provide technical direction for the project which is expected to cost upwards of $50 million.

C. I. Cummings, director of the lunar program for JPL, explained that Surveyor is the second step in the plan to explore the moon.

First step, Mr. Cummings said, is the Ranger series which will include five Ranger spacecraft, the last three of which are scheduled to rough land on the moon starting next year. The first two Ranger spacecraft will be sent on long elliptical trajectories away from the earth.

Rangers 3, 4, and 5 will be sent on trajectories to impact the moon. A survival capsule, surrounded by crushable material to help absorb the shock of impact, will be detached from Ranger near the moon and a retrorocket will fire to slow the capsule down to something under 300 miles an hour at landing.

Contained in the capsule will be some 8 pounds of instrumentation, including a simple, 1-axis seismometer to record moon quakes or meteoritic impact. There will also be chemical batteries and a transmitter to report these events back to earth.

Ranger will be fired from Cape Canaveral by the Atlas Agena B rocket system, it was stated.

With the greater weight-lifting capability of the Atlas Centaur system available for the Surveyor project, the weight of the working instrumentation that can be landed on the moon will rise correspondingly.

Surveyor will weigh some 2,500 pounds when it is injected into the lunar impact trajectory. After retrorocket fires and it lands on the moon, Surveyor will weigh 750 pounds, of which more than 200 pounds will be working scientific and engineering instrumentation.

Prospector, the third step in the NASA lunar exploration program, will use Saturn as a launching vehicle. Since Saturn will be capable of accelerating payloads of the order of several tons to lunar transfer speeds, among the missions now visualized are mobile experiments on the moon and the return of lunar material samples.

W. E. Giberson, JPL Surveyor project manager, said the feasibility of the Surveyor mission was determined by JPL as the result of a study which started about 16 months ago.

All seven Surveyors will be launched from the Atlantic Missile Range at Cape Canaveral, Fla., using the Centaur launch vehicle. The Centaur, a 2-stage rocket, will have a Convair Atlas as a first stage and will use a second stage incorporating the liquid hydrogen-liquid oxygen engine now being developed by Pratt & Whitney at its West Palm Beach, Fla., facility.

Dr. A. E. Puckett, vice-president of engineering at Hughes Aircraft, described the events following the injection of the Surveyor spacecraft into a lunar trajectory.

After separation from the Centaur, Dr. Puckett said, the Surveyor will maneuver to align itself to the sun and earth. These maneuvers will be accomplished by optical sensors and tiny gas reaction jets located on the spacecraft. The Surveyor will maintain this coast attitude with its solar panels directed toward the sun.

After about 20 hours of its 66-hour flight to the moon, engineers at NASA's Deep Space Instrumentation Facility, who will be continually tracking the spacecraft, will radio instructions to the Surveyor to adjust its flight path so that it will intercept the moon.

As Surveyor approaches the moon, television cameras will be turned on automatically and pictures of the lunar surface will be transmitted back to earth. Then a large retrorocket and three vernier rockets will fire to slow the descent. After the retro burns out, it will be separated from the spacecraft, and with the verniers still burning, the Surveyor will slow down to about 6 mph and land gently on the moon. Surveyor's landing speed will be slightly slower than a manned parachute landing on earth.

Dr. Leo Stoolman, Hughes Surveyor project manager, said the Surveyor television system consists of four cameras, three pointing up and one down, all fixed in position.

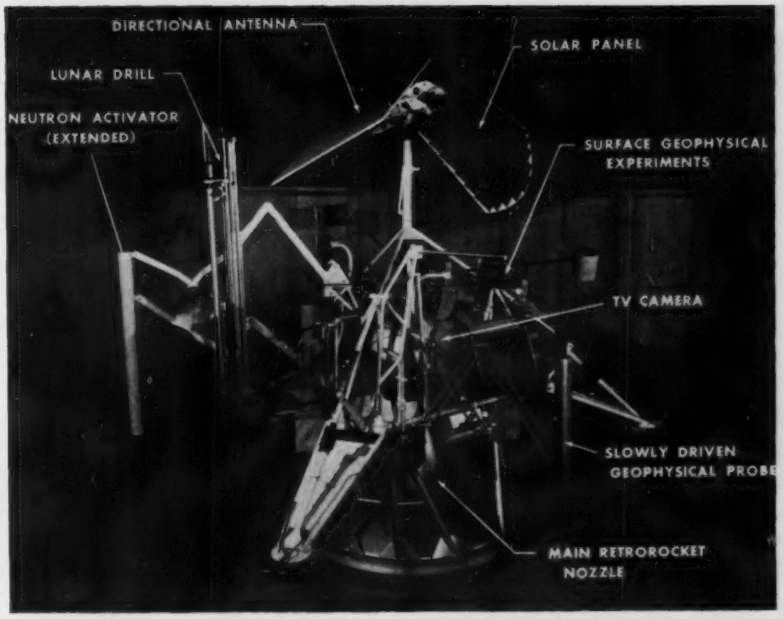
Above each of the upward-viewing cameras is a gimbal-mounted mirror capable of directing the television cone of vision through 369 degrees of azimuth and from 15 degrees above to 45 degrees below the horizontal line of the spacecraft.

A drill designed to penetrate the surface of the moon to a depth of from 18 inches to 60 inches, will be lowered from the spacecraft. As it drills, small fragments of the moon's crust will be collected from the hole and distributed to different instruments for analysis.

One of the television cameras will be used to monitor the drill so that scientists can watch on their television screens and observe the drilling operation.

Some of the other Surveyor scientific instruments will be a sensitive seismometer to record moon quakes or meteoritic impacts, a sensitive magnetometer to determine if the moon has a magnetic field, instruments to measure the gravity of the moon, and instrumentation to measure radiation and lunar atmosphere.

The Surveyor will operate on the lunar surface for at least 1 month. **EE**



THE National Aeronautics and Space Administration has chosen the Hughes Aircraft Company, Culver City, Calif., for contract negotiations leading to the building of a Surveyor spacecraft. Hughes will build seven Surveyors similar to the full-scale model shown, under the technical direction of the California Institute of Technology Jet Propulsion Laboratory. The 11-foot tall Surveyor will soft land about 750 pounds on the moon in the period 1963-65.

Microtherm Electric Water Heater

A briefcase-size electric water heater which provides an inexhaustible supply of temperature-controlled hot water has been announced by the Thermotronics Corp.

The compact Microtherm unit incorporating "Flow Touch" automatic push-button control weighs only 16 pounds and can be installed virtually any place in home, office, or commercial buildings without large water storage tanks or lengthy double pipelines. Utilizing a "thermal brain," the unit senses the temperature differential between the incoming water supply in summer or winter and automatically monitors and controls the flow and balances the heat transferred to the outgoing water at a temperature consistent with preset standards. The Flow Touch companion accessory also provides electronic precision control for flow and temperature as well as automatic cycling of fill, drain, and rinse operations.

As a "hydronic" home heating unit, Microtherm is said to save hundreds of dollars over the simplest current home heating operation in initial cost, cost of installation, and maintenance. Despite its small size, Microtherm can heat an entire home economically and automatically and it is almost completely repair free. The unit utilizes the most advanced components, including Union Carbide's new graphite woven fabric resistance element which is nonlining and noncorrosive. It also contains trinsistor-controlled rectifiers of the highest caliber.

Microtherm carries a 10-year guarantee against defects in manufacture. Its key components have been approved by Underwriters' Laboratories, Inc. **EE**

Heat, Cold Come from Same Source in New Device

A tiny device that can produce either heat or cold on demand, and so efficient it can freeze or boil a drop of water on power from two flashlight batteries has been developed by Hughes Aircraft Company scientists, the company disclosed recently.

The device, smaller than a paper clip, heats or cools at the flip of a switch. In clusters, its uses vary from maintaining room temperature in a space ship to operating an instant-defrosting refrigerator

POWER from two flashlight batteries can freeze water by means of a new thermoelectric device developed at Hughes Aircraft Company, Culver City, Calif.—but that's only half the story. When a switch reverses current flow, the device becomes a heater and in a few seconds the ice disappears in a wisp of steam. Hughes scientists say the development has wide uses in controlling temperature in space vehicles, heating and cooling homes, and designing instant-defrosting refrigerators with no moving parts.

with no moving parts, according to G. G. Messick of the Hughes aerospace research and development laboratories.

The device works on a principle of thermoelectric cooling which has been known for more than 100 years but was impractical because of the large amounts of current—from 20 to 30 amperes—that were required, Mr. Messick explained.

"Hughes developed a new technique of fabricating the thermoelectric material that makes it possible to operate at one-tenth of the current previously needed," he said.

A thermoelectric device—also known as a Peltier cooler—produces heat at the junction of two special semiconductor materials when a current is passed through it. It cools when the direction of current flow is reversed. As a result, the same element can be used for both cooling and heating by connecting a simple switch in the circuit to control the direction of current.

Because of its current requirements, the device is ideal for use in a space vehicle, either for making passengers comfortable or for cooling electronic systems. Its heating efficiency is up to eight times as high as conventional resistance heaters such as an electric toaster or stove elements.

A 3-stage "cascaded" cooler has been built that brings temperature down to —100 F and is being used to cool an experimental infrared detector. The device requires only 2 amperes of current.

"A heat-control oven is also being built which will hold an even 70-degree temperature in weather varying from 40 below zero to 180 above while using less power than an automobile headlight," Mr. Messick said. "Even greater temperature extremes and higher efficiency are expected as newer materials are discovered."

The future uses of thermoelectric applications were described as virtually limitless. All the kitchen appliances that produce either heat or cold may eventually operate on this principle. Homes may be heated and cooled by the same wall panels. Critical electronic components can be "spot cooled" to boost reliability by as much as 500%. **EE**

Huge LTC Autotransformers For N.Y. State Power Authority

Scheduled for installation at the Niagara switchyard of the Power Authority of the State of New York are two huge load tap changing (LTC) autotransformers—the largest (in physical size) ever built by Allis-Chalmers. These units also have record capacity for their extra-high-voltage class. Rated 400,000 kva, each unit weighs 730,000 pounds and will connect the 345,000-volt and 230,000-volt sections of the Niagara switchyard at Lewiston, N.Y.

Located on the plateau at Niagara Falls, the station is near the Tuscarora Power Plant for which Allis-Chalmers is furnishing 12 large reversible pump-turbines. The pumps are each rated to deliver 3,400 cubic feet of water per second against the storage pond head of 85 feet. As turbines, in reverse rotation, they are each rated 28,000 hp under a 75-foot operating head.

Power will be channeled through these transformers across New York State on the Power Authority's 345-kv system connecting with Rochester Gas and Electric Company. Just north of Utica the line will have connections with a 345-kv line being built from there to New York City by Niagara Mohawk Power Corporation and Consolidated Edison Company. **EE**

Solution Developed to Growing Problem of RFI

A solution to the growing problem of radio-frequency interference (RFI) from high-power microwave transmitters, has been developed by the General Electric (GE) Power Tube Department.

Scientists and engineers at the department's Traveling-Wave Tube Product Section, Palo Alto, Calif., have perfected a technique for making waveguide power filters which effectively eliminate RFI caused by harmonics, Dr. C. G. Lob, manager of the section, revealed recently.

Working on a principle analogous to that of the common automobile muffler, GE's new filters absorb the unwanted harmonic signals produced by all transmitting tubes, but still allow the intended fundamental frequency to pass through with its power undiminished.

Dr. Lob warned that RFI is already a serious problem because of the large number of powerful microwave transmitters now operating and the certain future increases in that number.

Most troubles now are between high-power radars which produce as many as a dozen harmonic frequencies in addition to their fundamentals, and sensitive microwave relay links. Dr. Lob said there had been a number of instances where unwanted signals from high-power transmitters had caused malfunction or interruption in sensitive microwave receivers.

He predicted a sharp rise in such instances as today's 12,000-plus radar transmitters are increased in number and power, and as the current 7,000 microwave relay stations more than double to 17,000 in the next 5 years.

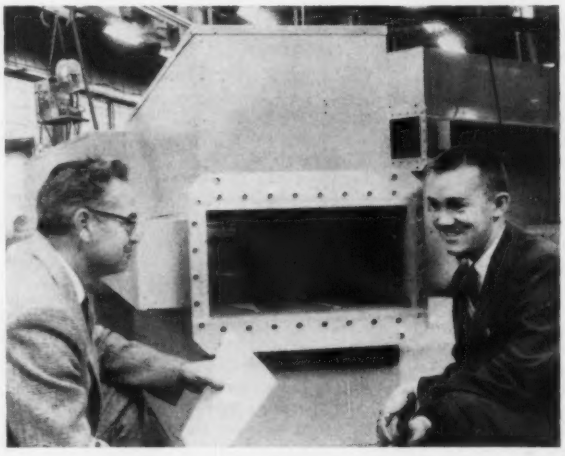
The problem calls for immediate action, and an effective solution lies in GE's harmonic filters, V. G. Price, manager of filter design, said.

Designed primarily for use in high-power transmitters, the harmonic absorption filters already available operate in frequency ranges from 400 to 6,000 mc.

Mr. Price added that other types now in advanced development operate up to 10,000 mc and that the technology developed during the past 5 years makes it feasible to design filters to meet needs as high as 40,000 mc.

The filters are designed for installation in the waveguide system, as close as possible to the transmitting tube.

In addition to the main function of eliminating RFI caused by harmonics, the filter performs another important func-



GE's *MPF-400* harmonic absorption filter for high-power radar transmitters is given preshipment inspection. Manufacturing engineer Calvin Callender (left) and filter engineer R. L. Stone check unit at Power Tube Department's Traveling-Wave Tube Product Section. Notice openings in the sidewall of the filter through which spurious frequencies are absorbed.

tion. It serves to increase the power-handling capability of the waveguide system on the output side of the tube by eliminating waveguide arcing which results from harmonics.

The filter itself is constructed and installed so that apertures are positioned along the inside walls of the main waveguide. Harmonic signals are "leaked" away by a series of coupling slots and muffled in their associated secondary waveguides.

Filters in the present line range in size from one similar to an automobile muffler to one which is over 14 feet long.

Power Tube Department engineers have been working closely since 1955 with military agencies in devising methods of solving the interference problem. **EE**

Thin, Solid Panel Produces Moving, Lighted Image

An electronic panel less than ½ inch thick that utilizes a new principle to produce a moving, lighted image was described recently by a scientist of General Telephone & Electronics Laboratories, Inc.

Commenting on potential uses of the new device, Dr. Herbert Trotter, Jr., president of the research subsidiary of General Telephone & Electronics Corporation (GT&E), said, "It would be premature to speculate at this time on specific future applications. A great deal of research and engineering work remains to be done before the new development can be applied commercially."

One of the major advantages of the device, according to Dr. Trotter, is its ability to display an image on a thin, flat panel. Conventional electronic display devices use a cathode ray tube to produce an image.

The inventor of the device, Stephen Yando of GT&E Laboratories at Bayside, N. Y., described the new development as "an entirely new combination of electrical phenomena that have been in general use for a number of years—piezoelectricity and electroluminescence."

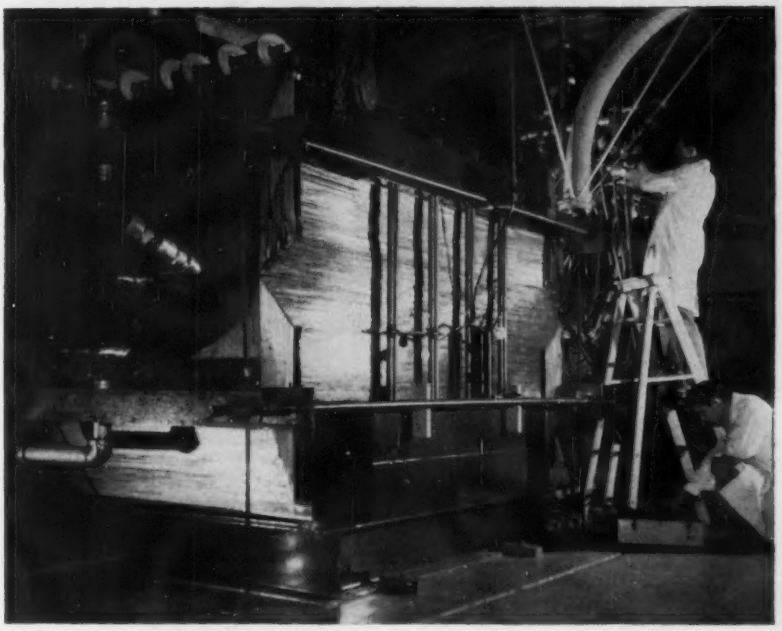
Piezoelectricity is the phenomenon exhibited by certain materials that expand in one direction and contract along other directions when an electric field is applied. Conversely, when mechanical stresses are applied to a flat plate of piezoelectric material, electric charges are developed on the face of the plate.

Electroluminescence involves the excitation of a phosphor coating on a thin, flat panel through the application of an electric field, thus causing the phosphor coating to give off light.

The new device consists of a thin, flat panel composed of a "piezoelectric ceramic material, one surface of which is coated with a layer of electroluminescent material. When voltage signals are applied to several electrodes on the edges of the flat piezoelectric panel, traveling acoustical waves are introduced into the ceramic material. Electric fields which accompany these acoustical waves interact with the electroluminescent layer to produce a "spot" of illumination on the panel. The position of the spot is controlled by varying the relative timing of the electrical pulses to produce an electronic wave pattern. The light intensity of the spot is modulated by an electric field applied to a transparent conductive layer covering the electroluminescent layer.

As suitably timed input signals are applied, a series of light spots or lines are produced which can form an image. By varying the timing of the signals, the image can be made to move about the panel. In certain applications, only a dot of light will be required. Nonlinear resistance material can be included in the panel to eliminate background light, leaving only the desired display. **EE**

MHD Power Generator



LARGE-SCALE magnetohydrodynamic (MHD) power generator being prepared for operation at Avco-Everett Research Laboratory. It will be used to evaluate engineering problems connected with generating power through the MHD principle. It is reported that an MHD generator has produced 205 kw for 10 seconds. Joining with the 10 operating utilities already participating with Avco in this MHD project are the Boston Edison Co., Boston, Mass., and the United Illuminating Co., New Haven, Conn.

New Research Directed to Mysteries of Fission Process

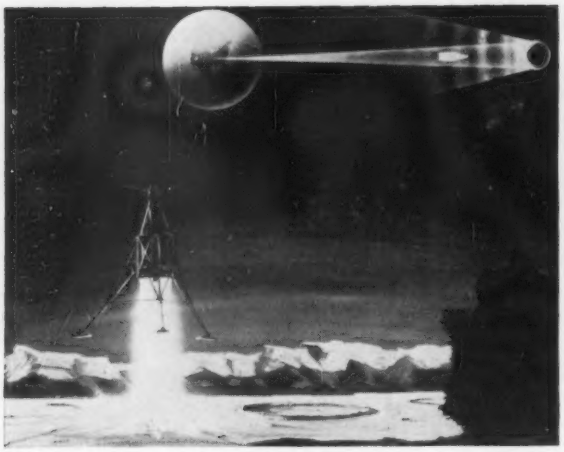
Prof. Fritz Strassmann, the co-discoverer of nuclear fission, recently announced plans to use split-second pulses of intense neutron radiation in a new attack on mysteries of the fission process which still remain unsolved 22 years after he and Prof. Otto Hahn found the way to unlock the energy of the atom.

Prof. Strassmann, who is director of the Institute for Inorganic and Nuclear Chemistry at Johannes Gutenberg University of Mainz, said he believes there are short-lived primary fission products, created in the splitting of the atomic nucleus, which have not yet been detected.

He said he hopes to identify and measure these elusive fragments, whose radioactivity decays so rapidly that they are difficult to discover and examine, by means of high-intensity pulses of neutron energy lasting only a few milliseconds. The beams of high-speed neutrons will be produced in a TRIGA research reactor, specially adapted for self-regulating pulsed operation by General Atomic Division of General Dynamics Corporation. The reactor will be the principal facility of a new $1.2 million research center to be erected on the campus of Johannes Gutenberg University. The center, which is expected to be completed in late 1962 or early 1963, will be a part of the institute which Prof. Strassmann has headed since 1954.

The "pulsed" neutron beam from the TRIGA reactor will be billions of times more intense than were the beams available to Prof. Strassmann and Prof. Hahn when they bombarded and split the nucleus of the uranium atom during experiments at the Kaiser Wilhelm Institute in Berlin in the winter of 1938-39.

The TRIGA will be a Mark II aboveground model with a normal operating level of 30 kw (thermal). The German Federal Government, through its Ministry for Nuclear Energy, has provided funds



A powerful beam of microwave energy aimed at the moon creates a "radiowave atmosphere" for soft landing space vehicles. The novel lunar landing technique was proposed by Dr. Frank Dickey, radar consultant with the General Electric Company's Electronics Laboratory in Syracuse.

toward purchase of the TRIGA and associated laboratory facilities.

Prof. Strassmann said he has been eager for some time to undertake the study of the influence of very high energy neutrons on nuclear fission and the properties and yields of fission products, particularly the short-lived ones. He also will study the chemical effects of intense beams of neutron radiation on organic and inorganic matter.

Using a cutaway model of the reactor, Prof. Strassmann explained that he will be able to "pulse" the reactor for fractions of a second with complete safety because it is self-regulating. Its uranium fuel is intimately mixed with the hydrogen moderator in solid form, in a structural lattice of zirconium. This provides the TRIGA with a "prompt negative temperature coefficient," which means, in effect, that it has a built-in "thermostat" which governs its safety.

As the nuclear chain reaction is speeded in the reactor's core, increasing the output of heat energy and raising the power to thousands of times its normal 30-kw level, intense neutron radiation occurs. Instantaneously, the hydrogen moderator absorbs the excess heat, slows down the neutrons, and automatically brings the chain reaction back to a normal rate. All this occurs in a few milliseconds, without use of control rods or other mechanical devices. **EE**

Scientist Proposes Novel Lunar Landing Technique

A scheme to create a "radiowave atmosphere" in the vicinity of the moon as a means for the soft landing of space vehicles was described recently by a General Electric Company (GE) scientist.

Dr. Frank Dickey, radar consultant with GE's Electronics Laboratory in Syracuse, N.Y., proposed the novel lunar landing technique before an audience attending a 4-day International Convention of the Institute of Radio Engineers. The session was entitled "This World and the Adjacent One."

In accordance with Dr. Dickey's plan, a powerful earth-based transmitter would be employed to beam microwave energy at the moon. The interaction of incident and reflected energy near the moon's surface would create a stationary radiowave pattern somewhat like an artificial atmosphere.

About 300 miles out, the incoming spacecraft would begin to sense the crests of the stationary radio waves and from them would derive all the necessary information about the vehicle's speed, orientation, and distance from the moon. With this "fix" the craft would then be able to make final adjustments with retro rockets for a soft landing. The irregularly shaped waves remain almost stationary even though the moon is moving.

"If one thinks of this field strength pattern as an atmosphere through which the spacecraft is moving, Dr. Dickey explained, "then the effect of the moon's motion may be described as a slight wind of less than a mile per hour."

The new technique will result in a simple, lightweight device to perform all of the sensory functions required to achieve soft lunar landings. He suggested that it might also be possible to use the same equipment for command radio messages that could activate any of the variety of equipment that is carried on the space vehicle.

"One big advantage of this system," Dr. Dickey said, "is that it provides navigational information earlier than other proposed radars and avoids the complexity of an inertial system."

Because the transmitter is located on earth and only small receiving equipment is carried aboard, he stated, the proposed system would be only a small fraction of the weight and size of other equipment of comparable accuracy.

Dr. Dickey pointed out that the saved weight and space would allow the craft to carry a scientific payload and would therefore make it capable of supplying more information about the moon when it gets there. **EE**

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, *Electrical Engineering* reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Thermonuclear Power

To the Editor:

In the article "The Quest for Thermonuclear Power" by R. G. Mills, *Electrical Engineering*, March 1961, pp. 176-81, the author has very interestingly shown the necessity for a holding back of the reacting fuel gas at its enormously high temperature of a hundred million degrees from the containing walls, and has intimated in his Fig. 1 (p. 178) that a sufficiently strong magnetic field parallel to the containing walls might accomplish this. However, an electric field can also set itself up perpendicular to the containing wall and the magnetic field, and under these circumstances the flow out of ions together with an equal and opposite charge of electrons may take place, as if no magnetic field at all were present. Thus, the blocking effect of the magnetic field which automatically sets itself pering cylindrical wall is completely eliminated by the self-induced radial electric field which automatically sets inself perpendicular to the magnetic field. The fabulous magnetic bottle may be merely a fantastic dream.

Now I have found[1] that if a flow of gas, ionized at a low temperature, is maintained from a specially placed inner cylinder across the vacuum space to the outer cylinder, and if the loss of positive ions to the end plates perpendicular to the magnetic field is prevented by holding these end plates at a high positive electric potential relative to the discharge, then the temperature of these positive ions where they discharge to the outer wall remains low. However in between, the positive ions and electrons rise in temperature and then cool to a low temperature at the discharge to outer cylinder again.

Now I am sure that Mr. Mills has heard of this proposed scheme over a year ago. Has it worked out?

JOSEPH SLEPIAN (F '27)

1. The Ionic Centrifuge and Fusion Nuclear Power, J. Slepian, *Proceedings* of the National Academy of Science, vol. 47, No. 3, March 1961.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ABSORPTION AND DISPERSION OF ULTRASONIC WAVES. By K. F. Herzfeld and T. A. Litovitz. Academic Press, Inc., 111 Fifth Avenue, New York 3, N. Y., 1959, 535 pages, 6¼ by 9¼ inches, bound. $14.50. This book deals exclusively and in detail with the molecular basis of the absorption and dispersion of ultrasonic waves. Section A presents the general theory of relaxation in fluids, with a minimum of formulas. Section B deals with gases, applying the general formulas and describing experimental methods to determine velocity and absorption, experimental results in molecules without electronic excitation, and vibrational and rotational energy exchange. Section C deals with liquids, reviewing the theories of liquids and the development of ultrasonic absorption and dispersion in this media, and examining experimental methods of determining dispersion and absorption, Kneser liquids, and associated liquids and liquids with high velocity.

ANNUAL REVIEW OF NUCLEAR SCIENCE, 1960. Edited by Emilio Segrè and others. Annual Reviews, Inc., Palo Alto, Calif. 617 pages, 6¼ by 9 inches, bound. $7. This 10th annual review contains 15 monographs, each well-documented, dealing with the following topics: neutrino interactions; nuclear interactions of heavy ions; cosmic ray showers, and cosmic ray experiments during IGY; bubble chambers; optics of high-energy beams; nuclear structure in internal conversion; recoil techniques in nuclear reaction and fission studies; recoil methods for labeling organic compounds; the general formalism, experimental data, and phenomenological analysis of nucleon-nucleon scattering experiments; cellular and vertebrate radiobiology; nuclear methods for subsurface prospecting; and the energy levels of light nuclei. Also included are cumulative author and chapter-title indexes for volumes 1-10 of the series.

BRITISH ELECTRICAL POWER CONVENTION, PROCEEDINGS, TWELFTH, 1960. Published by the Convention, London, England. 356 pages, 5¾ by 8¾ inches, bound. Price not given. The four papers, with discussions, published here are keynoted by the theme of the convention: "Electricity—the New Horizon," and emphasize future developments. The topics discussed are: electrical supply sources and activities in England and Wales; electricity in industry, both as a power source and in manufacturing control, and relevant to the products manufactured; the export of electrical products, from power station equipment to household appliances; domestic uses of electricity. The volume also contains convention statistics, such as council and committee personnel, membership, and the report of the Annual General Meeting, and a bibliography of papers presented at all 11 conventions, from 1949 to date.

CREATIVE ENGINEERING DESIGN. By H. R. Buhl. Iowa State University Press, Press Building, Ames, Iowa, 1961. 195 pages, 7 by 9¼ inches, bound. $3.95. This book whimsically draws on an intriguing variety of sources, from "Machine Design" to the "Saturday Evening Post," and "Alice in Wonderland" for quotations and cartoons to support the sound suggestions and techniques presented. The aim of the book is to develop in the reader a capacity to design. The author makes a keen analysis of the particular challenge to imagination and creativity which distinguishes design problems from other engineering problems, and, effectively pointing out why some designs are not creative, he describes the particular traits of the creative design engineer and his techniques. The various steps in the process of creative design are carefully presented, from recognition and definition of the problem to evaluation and presentation of the solution. Somewhat of a popularization, with an unusual format, this book offers a stimulating and refreshing viewpoint.

DYNAMIC MANAGEMENT IN INDUSTRY. By Raymond Villers. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. 516 pages, 6¼ by 9¼ inches, bound. $10. This is a study of the application of scientific methods to industrial management, and of the function and scope of management science within the organizational structure of the industrial enterprise. Existing concepts of management are reviewed in terms of their historical development, the various theories of organization are discussed, and the concepts of functional decentralization and of functionalization of planning and control are all studied in detail. The point of view is dynamic, considering the introduction of the principles in a going business, and actual case studies are presented to illustrate the principles discussed.

ELECTRONICS IN ENGINEERING. By W. R. Hill. Second edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1961, 340 pages, 6 by 9¼ inches, bound. $8. As in the first edition, this is an introduction to electronic devices and their properties for engineering and science students. The primary change in this second edition is the introduction of semiconductor devices, and discussing circuit analyses for vacuum and for semiconductor devices together. Topics covered include the diode, rectifier and amplifier circuits, resonance and tuned amplifiers, amplitude modulation and demodulation, solid-state switching devices, photosensitive devices, feedback, oscillators, transducers, transistors, the analog computer, and the cathode-ray oscilloscope.

THE ENCYCLOPEDIA OF SPECTROSCOPY. Edited by G. L. Clark. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y., 1960, 787 pages, 7¼ by 10¼ inches, bound. $25. A compilation of brief review articles by authorities from industry, universities, and governmental organizations in the United States, Britain, and Europe, dealing with 23 principal kinds of spectroscopy, and discussing for each method its history, theory, instrumentation, techniques, interpretations and applications. Each method is thoroughly but briefly discussed, well-illustrated, and documented. Topics include absorption, band, beta-ray, emission, infrared, microwave, raman, solar, and vacuum spectroscopy; flame and absorption photometry, fluorophotometry and phosphorimetry; and resonance, gamma-ray, infrared, neutron, and emission spectrometry.

INDUCTION HEATING. By P. G. Simpson. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960, 295 pages, 6¼ by 9¼ inches, bound. $11.50. This book describes procedures for the design of coils, power systems, and generating equipment for applications in induction heating. Economy and technical conditions are both fully considered. Descriptions of such typical processes as low-frequency through-heating, localized metal joining at higher frequencies, and accurate surface hardening are given, along with the coil and systems designs for these applications. The methods and data were collected from work performed by divisions of Westinghouse Electric, and of General Electric and Redifon, Ltd., of England.

INFORMATION RETRIEVAL AND MACHINE TRANSLATION, PART I. *(Advances in Documentation and Library Science, Volume III)* Edited by A. Kent. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960, 686 pages, 6¼ by 9¼ inches, bound. $23. The first part of a 2-part volume recording the papers and discussion of the International Conference for Standards on a Common Language for Machine Searching and Translation, sponsored by the Rand Development Corporation and Western Reserve University in September 1959. Some 60 papers were presented by representatives of 10 countries, and 21 of the papers, with discussions, are published in this volume.

INTRODUCTION TO NUCLEAR SCIENCE. By Alvin Glassner. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1961, 213 pages, 6¼ by 9¼ inches, bound. $3.75. This elementary survey of nuclear science and its impact upon the other physical and natural sciences is based on a summer course given for high school science teachers by personnel of the Argonne National Laboratory. The lectures reflected the activities of the laboratory, and the material in this book, taken from these lectures, is kept as nontechnical as possible, eliminating mathematics, and emphasizing recent developments and experimental and laboratory aspects of nuclear science. The 12 chapters deal with the nuclear atom and nuclear particles, natural radioactivity, nuclear phenomena such as spin, parity, stability and models, nuclear reactions, radiation and its detection, biological aspects, and effects on materials, high-energy accumulators, reactors and the processing of reactor fuels, and the metallurgy of uranium. The final 20 pages describe specific experiments in nuclear science.

MECHANICAL WAVEGUIDES. By M. Redwood. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1960, 300 pages, 5½ by 8¾ inches, bound. $9. This introduction to the properties of guided waves describes elementary principles, and also presents a comprehensive survey of recent research and advanced aspects. The discussion covers propagation, reflection, and refraction at an interface; continuous waves in fluid waveguides, solid plates and solid cylinders; pulses in fluid and solid waveguides; multilayered waveguides; solid resonators; and anisotropic media. The emphasis is on theoretical analysis, with supporting experimental techniques given only as references in an appendix. Other appendixes give vector notation, properties of Bessel, Neuman, and Hankel functions, mechanisms of acoustic loss, and synthesis of a cylindrical wave from plane waves.

DAS MESSEN MIT ELEKTRISCHEN GERÄTEN. By Hans Neumann. Springer-Verlag, West Berlin, Germany, 1960. 640 pages, 6½ by 9½ inches, bound. DM 55.50. Despite the continuing changes in electrical measuring techniques, some principles remain standard. The control of these constitutes the "art of measuring" and is the essential basis for this book. Particular emphasis has been put on the operation and use of measuring equipment as well as on a critical evaluation of the results. In addition to examples from working practice, the meaning of various measurements and the application of characteristic evaluation methods are presented.

SERVOMECHANISMS. By P. L. Taylor. Longmans, Green and Company, Inc., 119 W. 40th St., New York 18, N. Y., 1960. 418 pages, 6½ by 10 inches, bound. $8.50. A text for students, this book deals primarily with mechanisms employing electrical, electromechanical, and electronic components, utilizing theorems already employed in "Electric Circuit Theory" (H. Tropper, Longmans, 1949). Part one discusses the aims of the book, and the transmission and modification by computation of the data on which the control system is to act. Part two develops quantitatively and qualitatively the ideas of part one, and describes methods of controlling and improving the performance of servomechanisms, to explain why they should behave as they do. Part three presents an outline of the general theory of linear closed-loop control systems, omitting entirely discussion of the problem of synthesis, and of nonlinear systems, and systems subject to random inputs.

THERMAL REACTOR THEORY. By A. D. Galanin. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1960. 412 pages, 5½ by 8¾ inches, bound. $15. This translation re-

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flects the work of Soviet Scientists in the development of thermal reactor theory prior to the Second Geneva Conference in 1958. Knowledge of the elements of nuclear physics and kinetics theory is assumed. The 10 major sections of the book deal with: diffusion and slowing down of neutrons; the critical size of a reactor; multiplication, slowing-down, and diffusion in a homogeneous medium; heterogeneous reactors; perturbation theory; the isotopic composition of nuclear fuel; delayed-neutron kinetics; and the Boltzmann equation.

TRANSISTORS. By W. W. Gärtner. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 675 pages, 6¼ by 9¼ inches, bound. $12.50. A college text, written to provide the introduction and background in transistor operation and circuitry required for professional practice and original design work in the field develops basic concepts in physics and in electrical circuitry from an elementary level. The first part of the book describes the invention, development, and action of the transistor, and outlines the plan of the book. Part 2 deals with semiconductor physics in terms of basic concepts, semiconductor properties, and P-N junctions. Part 3 gives details of transistor design, construction, and characteristics. The final, and major, section of the book is devoted to transistor applications, in amplifiers, oscillators, and pulse circuits.

TRAVELING-WAVE ENGINEERING. By R. K. Moore. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N. Y., 1960. 360 pages, 6¼ by 9¼ inches, bound. $11. Dealing with distributed parameter systems where the point-to-point traveling time of a disturbance is significant, this book treats transmission lines in detail, applying methods widely used for transmission lines to such "wave" phenomena as vibrating strings and acoustics, and such "diffusion" phenomena as heat conduction and molecular and charge-carrier diffusion. Plane waves are assumed except in the chapter dealing with spherical waves. Basic wave concepts for the transmission line are developed first, with comparable equations for the other waves derived in the following chapter. Thereafter, new ideas are introduced in terms of transmission lines, and the analogous applications of each effect are immediately given. Linear systems only are discussed, and though the analogies are of general applicability, nonlinear waves will require different methods of analysis.

ULTRASONICS AND ITS INDUSTRIAL APPLICATIONS. By O. I. Babikov. Consultants Bureau Enterprises, Inc., 227 W. 17th St., New York 11, N. Y., 1960. 224 pages, 6¼ by 9¼ inches, bound. $9.75. This is a translation of a Moscow State Press publication of 1958. After a brief review of the development of ultrasonic technology, the propagation, generation, and absorption of ultrasonic oscillations are described in detail. The remainder of the book deals with specific ultrasonic techniques —in flaw detection, investigation of the microstructure of metals, physical–chemical analysis, machining hard and brittle materials, aluminum soldering and plating, and cleaning operations. The final chapter discusses the metallurgical effects of ultrasonic processing, and the utilization of these effects in improving the structure of a metal.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

EIA ELECTRONICS ENGINEERING STANDARDS. The Engineering Department of Electronic Industries Association (EIA) reports three new publications. **Guide for Measurement and Reporting of Electronic Equipment Maintainability** discusses such maintainability concepts as general objectives, availability and operational readiness, and operational support costs related to maintainability. A section on measurement, which reports of quantities, deals with the definition of the system and maintenance concept, quantities measured, descriptions of equipment design and use factors, and computational techniques; price $2. **Maintainability Digest for the Electronics Industry** is a revision of "Suggestions for Improving Maintainability of Military Electronic Equipment" presented at the 1957 EIA Conference on Maintainability of Military Equipment. It up-dates, improves, and expands the publication by providing guidelines for planning, specifying, designing for, controlling, and evaluating maintainability; price $2. **Electron Tube Types Versus Packaging Classifications** provides a guide to the procurement of tube types having limited co-ordination, and lists packaging group, container size, drop test, and other requirements as specified in Military Standard MIL-E-75; price $1. These documents may be ordered from the EIA Engineering Department, Room 2260, 11 W. 42nd St., New York 36, N. Y.

RESEARCH IN MICROELECTRONICS USING ELECTRON-BEAM-ACTIVATED MACHINING TECHNIQUES. A new high-speed micromachining method has been developed for fabricating film materials used in electronic data-processing systems according to a report of Navy research. The process employs an active element based upon the mechanical tunneling of electrons from a metal into high vacuum that has an estimated switching time of 10^{-10} seconds. In fabricating film materials, a micromachining method is employed that uses an electron beam to form a chemically resistant film on the material being machined, which is subsequently etched in vacuum by a molecular beam. The technique has resolution capabilities of several hundred angstrom units. It can handle electronically clean materials with minimum contamination and may ultimately be suited for the economical production of 1-cubic-inch data-processing systems with 10^{11} active components. Components based on the process couple well to similar and accessory components. Tests indicated that light detectors and generators and electrostatically operated electromechanical devices such as relays and filters seem to fulfill the requirements for accessory components so that all electronic functions could be accomplished with this microelectronic system. The publication is available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., for $3.50 each copy.

RESEARCH HIGHLIGHTS, *National Bureau of Standards, Annual Report 1960*. Presented in digest form, this illustrated account of the National Bureau of Standards (NBS) research and measurement activities describes 225 programs in 18 different fields. Included are determination of an improved value for the faraday; determination of a new value of the atomic weight of silver; development of a high-temperature electric arc for experimental temperature measurements in the region from 10,000 to 20,000 C; calibration of commercial gauge blocks to an accuracy of better than one part in five million; and the placing in operation of improved atomic frequency standards. Some details of a special program in plasma physics and laboratory astrophysics are given, including studies of the properties of electromagnetic radiation and of particles and their interactions. In other research programs described, the length of the international standard meter bar was related to the wavelength of the organge-red light emitted by the isotope krypton-86. In addition, a complete list of NBS publications and patents for fiscal 1960 is included. The document is available from U. S. Department of Commerce, National Bureau of Standards, Washington 25, D. C., for 65¢.

OERSTED AND THE DISCOVERY OF ELECTROMAGNETISM. Written by Bern Dibner, author of "Laying the Atlantic Cable," this monograph chronicles concisely and graphically the somewhat fragmentary history of electromagnetism. The link between electricity and magnetism, which Oersted first demonstrated in 1820 by his simple experiment, underlies almost everything electrical and electronic developed since, from powerful dynamos to sensitive instruments. Proof that electric currents produce magnetic fields ranks with Volta's and Faraday's discoveries as one of the three great findings that form the foundation of the Age of Electricity. Dr. Dibner reproduces original material seldom published before in the United States, drawing his material mainly from original sources in the Burndy Library. The 48-page monograph is available from Burndy Library, Norwalk, Conn., for $2 in paper cover.

IRE TRANSACTIONS ON INSTRUMENTATIONS, *Vol. I-9, No. 2*. This volume contains a complete compilation of scientific papers presented during the 1960 Conference on Standards and Electronic Measurements held in June at the National Bureau of Standards (NBS) Boulder, Colo., Laboratories. Sponsored by the AIEE, the Institute of Radio Engineers (IRE) and the NBS, the conference was attended by more than 800 scientists and engineers from industry, universities, and government. Among the topics covered are standards and measurement techniques for electrical quantities at frequencies ranging from direct current through the microwave region, the most pressing current problems in establishing universally accepted consistent standards, and a considered speculative look at the most probable causes of difficulty in the future in making standards and electronic measurements. Available from The Institute of Radio Engineers, 1 E. 79th St., New York, N. Y., at $6.30 per copy for IRE members $9.45 for libraries and colleges, and $12.60 for all others.

1956 BIBLIOGRAPHIC SURVEY OF CORROSION, *Nace Publication No. 60-12*. This is a collection of more than 2,000 abstracts of technical literature published during 1956 in periodicals throughout the world related to articles, books, and pamphlets on corrosion and corrosion control. Also included are a small number of abstracts of material published in earlier years not previously included in bibliographies. Abstracts are indexed in the book according to their principal content under eight main headings: general, testing, characteristic corrosion phenomena, corrosive environments, preventive measures, materials of construction, equipment, and industries. Each of these groups is further subdivided. The survey may be ordered from the National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Texas, for $27.50 per copy for nonmembers and $22.50 for members of NACE.

FOREIGN ELECTRONIC ENGINEERING, TV, AND RADIO LITERATURE TRANSLATIONS. The following translations have been released for sale to the public through the Office of Technical Services: (OTS) *60-21466 Methods for the Control of Interfering Currents Originating at the Input of an Electrostatic Fluxmeter During its Operation in a Conducting Medium* (USSR), May 1960, 10 pages, 50¢; *60-21917 Chinese Communist Development of Teleprinter and Facsimile Equipment*, June 1960, 22 pages, 75¢; *60-31230 Information and Reports—Radio und Fernsehen* (German Democratic Republic), June 1960, 5 pages, 50¢; *60-41031 News of Institutes of Higher Learning—Radio Engineering* (USSR), July 1960, 286 pages, $4; *60-21184 Reciprocity Calibration of Underwater Sound Transducers in a Free Field—Acoustica* (Switzerland), 1960, 16 pages, 50¢; *60-21030 The "Pentaconta" Automatic Telephone System* (Societe Francaise des Electriciens Bulletin), 1960, 24 pages, 75¢; *60-41131 Experimental Apparatus for Three-Dimensional Color Television*, (USSR), August 1960, 7 pages, 50¢; *60-11971 Inter-Institutional Conference on the Application of Physical and Mathematical Modeling to Electrical Engineering Problems* (USSR), August 1960, 6 pages, 50¢. All these publications may be ordered from the OTS, Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C.

LIGHTING . . . KEYED TO TODAY'S HOMES. Written in layman's language, but in every way compatible with Illuminating Engineering Society lighting and vision recommendations, this new report provides a practical guide to combining and enhancing fashionable home decor with correct light for living. Illustrated with more than 250 photographs and drawings, the book has been designed specifically to give home lighting and related information to architects, interior designers, teachers, electrical contractors and electricians, manufacturers and distributors of home lighting equipment, etc. Copies are available at $1.50 each from the Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

ENGLISH ELECTRIC CANADA

USES

NATVAR

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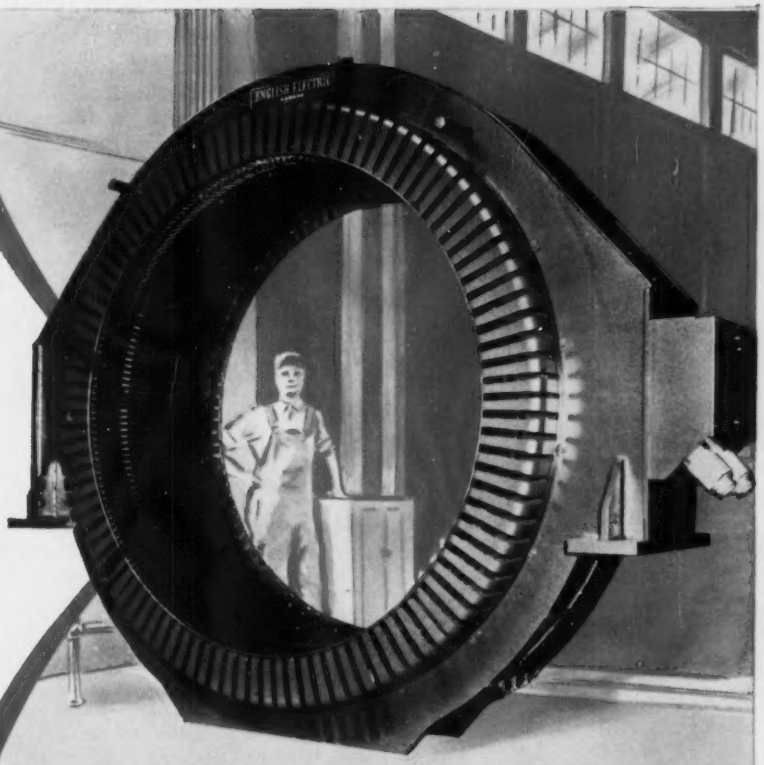

This unit, one of four built by English Electric for export to Europe, is a 4500 HP, 6000 V, 3-phase, 50 cy. synchronous motor stator. Coil ends are taped with Natvar Teraglas, a new flexible insulating material comprising a base fabric woven from polyester (polyethylene terephthalate or "Dacron") warp yarns, and continuous filament glass filler yarns, coated with an improved varnish possessing exceptional dielectric strength under elongation.

English Electric Canada, Toronto, Ontario, Division of John Inglis Co. Ltd. manufacture electrical motors, controls, transformers and switchgear for use in important installations throughout the world.

They have found that Teraglas offers several distinct advantages over the thirsty cotton base tapes formerly used. At no advance in material cost, Teraglas is more readily applied to coils; the higher dielectric strength of Teraglas results in a better insulated coil; and better heat resistance provides a greater safety factor against high operating temperatures due to overloading.

If you are presently using conventional materials, it will pay you to consider the ease of use and extra protection of Teraglas. It is made in four standard thicknesses, .008", .010", .012" and .015", available in sheets, rolls or tapes in black and yellow.

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- Varnished cambric—sheet and tape
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- Varnished silk and special rayon—sheet and tape
- Varnished papers—rope and kraft—sheet and tape
- Varnished, silicone varnished and silicone rubber coated Fiberglas®—sheet and tape
- Slot cell combinations, Aboglas®
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- Iseglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fiberglas tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

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We will be very happy to supply information on any of our products on request.

BENDIX
Needs
MANUFACTURING ENGINEERS FOR MAGNETIC COMPONENTS

Bendix of Kansas City, Missouri needs Manufacturing Engineers to do original work with new materials, and close, more exacting work with ordinary materials—minds that will inquire into the many branches of technology and bring together that combination of techniques capable of producing a unique product. As a Prime Contractor for the Atomic Energy Commission, our function is to give the weapon Designer the greatest possible latitude in exploiting new materials and techniques. We do this by paralleling his design work with advanced development of manufacturing processes during the design phase. The control of processes frequently must be so precise that automation is required for that reason alone—production quantity notwithstanding.

*These are positions for Electrical or Mechanical Engineers with experience in the manufacture of magnetic components. To qualify, you will need to understand design, processing and production in magnetic components for miniaturized high reliability application. Our work includes specific components such as audio, video, IF and pulse transformers and inductors of both toroid and conventional laminated designs. Also involved are magnetic amplifier components with very closely controlled electrical and magnetic parameters. A typical example of one of the new subminiaturized designs would be a four winding pulse transformer completely encapsulated and occupying a total volume of about ½cc and using wire sizes between A. W. G. 40 and 50. One of our needs is to develop realistic manufacturing techniques for the fabrication of a family of magnetic components similar to the above example with high quality standards and in moderate production quantities.

These are responsible positions for engineers who are qualified to do original and creative work, and who can demonstrate by a record of past professional accomplishment that they possess this ability. Ours is one of the nation's most vital industries. We offer unusually generous company benefits in a Midwestern community which is famous for its beauty and low cost of living. All replies will be strictly confidential.

For Personal Interview Send Resume to
Mr. K. L. Beardsley
Box 303-VC

THE Bendix CORPORATION

KANSAS CITY DIVISION
95th & Troost, Kansas City 41, Missouri

New Products

(Continued from page 22A)

Overload Coupling . . .

A new overload protector coupling warranted for 1 million disconnect-reconnect cycles, fits motor and machine shafts from ⅜- to 1½-inch diameters and can be ordered preset to disengage at any torque setting from ½ to 60 foot pounds. The Torq-Tender can remain for an unlimited time in the disengaged position without overheating or binding. It automatically re-engages when overload is corrected and when the motor is operated at low rpm or turned off and started again. The unit always re-engages in the same position, so there are no timing problems. *Helland, Inc., Navarre, Minn.*

Wattmeter . . .

This wattmeter for measurement of transformer core and corona losses on high-voltage transmission lines is particularly suited to low power factor measurements of 2 to 20% where normal wattmeter movements cannot function accurately. The device consists of an electrodynamic torque-producing mechanism and a d-c balancing element; all mounted on the same shaft and using taut-band suspension frictionless principle. When the electrodynamic element is energized, a deflection from the balance position produces an error signal in a photoelectric detecting system, which in turn causes a current to flow in the d-c balancing element to develop opposing torque to the electrodynamic element. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*

Miniaturized Flasher . . .

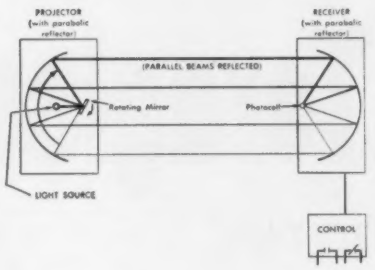
The *A-300-P* series is designed to provide military, aircraft, industrial, and marine fields with a lightweight, maintenance-free flashing device for incandescent lamps. Capable of switching 150 watts through a long service life under severe environmental conditions, the component is fully transistorized and potted. With basic circuity it can be used in conjunction with a warning signal or as a timing circuit where the on-off ratio or on-off time can be varied to meet required specifications. *Joseph Pollack Corp., 81 Freeport St., Boston 22, Mass.*

RPM Switch . . .

Small size and light weight are two important features of this new multi-speed rpm control switch. Models are available with 1, 2 or 3 snap-action, each set to actuate at a preset rpm. The flyweight-centrifugal force principle is employed to control switch operation. Repeatability and differential can be held as low as 1% or less while operating ranges between 700 and 5,000 rpm or higher are obtainable. *Kahn and Co., Inc., P. O. Box 516, Hartford 1, Conn.*

Protective Equipment . . .

Curtains of light, 7, 12, or 17 inches in width, sensitive to partial obstruction yet remaining unaffected by variations in normal ambient light constitute the main features of this labor-protective equipment. Employed in the projector is a rotating mirror from which a reflected beam of light



sweeps across the reflector to form parallel beams of light directed at the receiver. At that point, the light beams are focused by a second parabolic reflector to a photocell. The two electric pulses generated with each rotation of the mirror are then fed into the monitoring control unit. When an obstruction of more than 2 inches reduces the width of the light beam, a signal is produced that drops out the control relay, stopping the machine. *The Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.*

Hot Motor . . .

Capable of functioning in an environment that would melt tires from an automobile, this unusual motor will play a key roll in a new throttle-control system for the Air Forces' 2,000-mph B-70 bomber. With the frame made of stainless steel and wiring encapsulated in ceramic, the motor makes use of a unique aluminum anodizing method for wire insulation. Under development for 3 years, use of the motor-powered electric throttle system marks the first time that a nonmechanical system has been designated as a primary control in aircraft. *North American Aviation, Inc., Los Angeles 45, Calif.*

(Continued on page 30A)

FILM-COATED MAGNET WIRE FOR 220 C

Affords continuous high-temperature operation up to 250 C—resists heat shock up to 425 C

The exceptional heat stability of Anaconda ML Magnet Wire makes it ideal for electrical equipment operating at continuous high temperatures up to 250 C—such as high-temperature motors, relays and dry-type transformers. This same heat-resistant characteristic also makes ML Magnet Wire a valuable tool in miniaturization and in reducing the size of larger equipment.

Tremendous overload resistance (as demonstrated by thermo-plastic flow above 500 C and heat shock resistance over 400 C) makes ML Magnet Wire particularly suitable for portable tool armatures and other applications where "stall" conditions or unusual overloads may be experienced.

Essentially zero weight loss to 200 C makes it possible to use ML Magnet Wire for relays that will operate at temperatures up to 250 C with low space factor and comparatively low cost. Using ML Magnet Wire in sealed relays practically eliminates contact contamination due to "outgassing" of wire insulation.

Other ML Magnet Wire advantages: high burn-out resistance and cut-through level; dry dielectric strength over 3,000 V/Mil; excellent flexibility; good windability and scrape resistance.

ML Magnet Wire is coated with a solution of ML Polymer, a new chemical development by duPont that represents a tremendous improvement in heat resistance over organic coatings. ML Magnet Wire can be used as a replacement for most film-coated magnet wires, except solderable types, and many glass and glass Dacron wires. Where the positive inorganic spacing of glass is required, the combination of ML film and glass serving offers outstanding properties. ML Magnet Wire's combination of high temperature rating, excellent winding characteristics and space factor permits its use in many applications which formerly required the use of much more expensive combinations of ceramics and fluorocarbons.

ML Magnet Wire is available in all sizes of round, square and rectangular. Film additions are single, heavy, triple or quadruple thicknesses, all conforming with NEMA specifications. ML also meets all requirements of Spec. MIL-W-583B for Class 180 Types H, H2, H3, and H4, and Class 200 Types K, K2, K3, and K4. For prices, technical data and applications engineering information, contact Department EFL-1-EE, Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

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ANACONDA®
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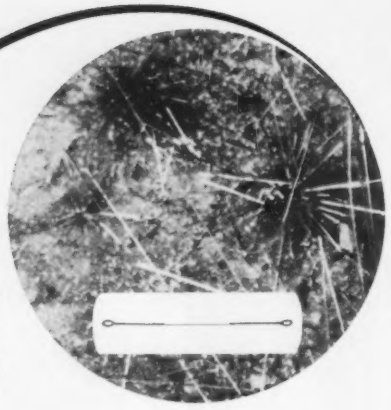


Silicon whiskers grown by vapor deposition techniques make possible new ultra-sensitive force transducers (inset above).

EPITAXIAL GROWTH AND ADVANCED TECHNOLOGY AT EOS*

Growing silicon whiskers under the exacting requirements imposed by vapor deposition techniques is more than the result of scientific curiosity. These single crystals, when used as ultra-sensitive transducers, allow physical and biological measurements 10 to 100 times more sensitive than possible with conventional strain sensors. Developing the sophisticated techniques and tools necessary for the advancement of the nation's technological efforts are the goals of EOS.

Ultra-sensitive pressure sensing devices are the practical result of only one of many programs being conducted by the Solid State Division. These comprehensive programs include the areas of materials research, microelectronics, and molecular electronics which in turn complement the research development and systems activities of the other Divisions of the company.

*Electro-Optical Systems presently has positions on its Technical Staff for **Physicists, Electrical Engineers, Mechanical Engineers, Chemists and Aerothermodynamicists** who are interested in advanced research and development programs and are experienced in the areas of

Solid State Physics
Materials Research
Fluid Physics
Electronic Systems
Energy Conversion
Advanced Power Systems
Electrochemistry
Quantum Physics
Re-entry Physics
Organic Chemistry

Scientists and Engineers are invited to direct inquiries in confidence to Mr. Don Smelser at

E ELECTRO-OPTICAL SYSTEMS, INC.
137 NORTH VINEDO AVENUE
S PASADENA, CALIFORNIA

New Products

(Continued from page 28A)

Business Machines . . .

Two fully transistorized machines mark the entry of this company into the data-processing field. The *2215* is a business document writing system that reproduces all repetitive data by means of programmed punched tape or edge punched cards, thereby eliminating the costly manual phase of repetitive writing. Typing of variables is the only manual operation required. The *6615* is an electronic computer with typewriter input-output that speeds and simplifies the preparation of business forms requiring calculation. A plastic program card is used for automatic programming control of this machine. *Smith-Corona Marchant, Inc., 410 Park Ave., New York 22, N. Y.*

Space Computer Drum . . .

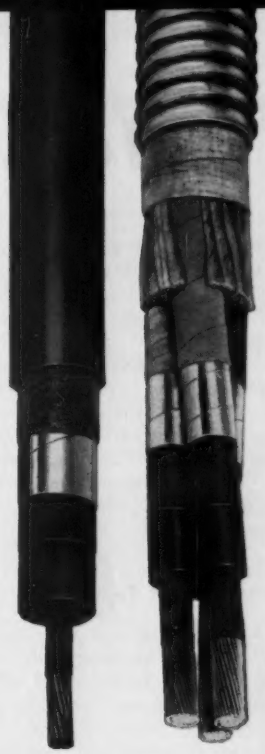
No larger than a baseball, this latest contribution to future space exploration features a memory drum capable of storing 358,000 bits of information for its parent computer. To explore neighboring planets, a computer might have to operate for years aboard a space vehicle with the drum spinning at 10,000 rpm, even when the computer is idle. "Infinite" life is achieved through air-bearing suspension of the rotor while floating heads pick up and record the data. Another feature is its "1-word loop" which speeds computer performance by enabling it to use information virtually as fast as it is received and deposited on the drum. *Sperry Gyroscope Co., Great Neck, N. Y.*

Subminiature Fuse . . .

The *GMT* fuse and *HLT* holder were designed to permit multiple mounting of fuses in extremely small places. Fuseholders may be panel mounted on ¼-inch centers. The wafer thin element permits removal of any blown fuse without disturbing adjacent ones. When the fuse opens, a colored flag flashes to draw attention to the open circuit. The spring carrying the flag also makes contact with an alarm signal circuit. Originally designed for communication equipment, its many features make it readily adaptable for computors, control devices, and other equipment where space is a premium and positive faulty circuit identification mandatory. *Bussman Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.*

How Circle exceeds the specs to give you...

MAXIMUM LONG TERM STABILITY



Most ordinary products generally manage to *meet* specifications. The quality product is recognized by the way it *exceeds* them.

Take, for example, Circlesheath Type RR Power Cable and the important IPCEA-NEMA 60 cycle water absorption test. Requirements call for immersion in water for 14 days with maximum SIC change and stability factor of 5% and 1% respectively.

The table below clearly indicates Circlesheath superiority – not only after 14 days submersion but after *two years and ten months in a test that was originated in September 1958!*

Long term stability is only one of the many ways Circlesheath exceeds specs to give users maximum performance. For complete reliability, specify Circle on your next job – there's no finer power cable made.

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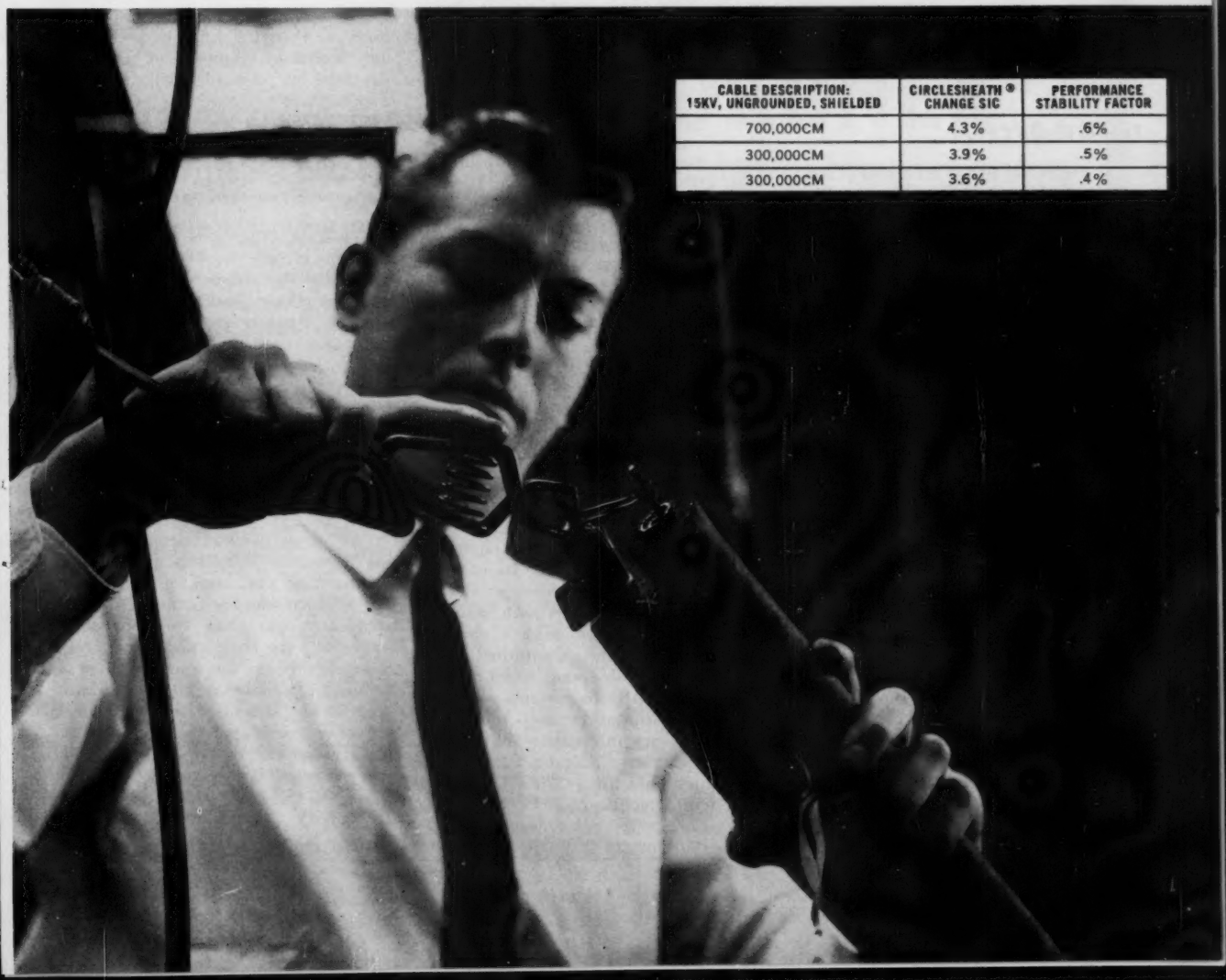


CABLE DESCRIPTION: 15KV, UNGROUNDED, SHIELDED	CIRCLESHEATH® CHANGE SIC	PERFORMANCE STABILITY FACTOR
700,000CM	4.3%	.6%
300,000CM	3.9%	.5%
300,000CM	3.6%	.4%

Trade Literature . . .

Torque Measuring . . .

A 12-page brochure illustrates how to measure the torque characteristics and speed of motors, gear trains, servomechanisms, and potentiometers. It covers torque ranges from ¼ gram-centimeter to 200 pound-inches. The brochure includes formulas for computing power and efficiency and methods of using stroboscopes and tachometers for analyzing rotating motion. *Power Instruments, Inc., 7352 N. Lawndale Ave., Skokie, Ill.*

Drafting Chart Reprint . . .

A reprint of a 6-page illustrated printed-circuit drafting aids chart is now available. Included are all of the precut pressure-sensitive shapes and narrow tapes required to make paste-up printed-circuit drawings that will conform to military specifications, together with many new nonmilitary configurations. Samples of "Kwiky-Dot" overlapping donut-type terminal pads are included with each chart. *By-Buk Company, 4314 W. Pico Blvd., Los Angeles 19, Calif.*

Tunnel Diode Circuit . . .

Booklet number AN-1359A, "Tunnel Diode Circuit Design Handbook," contains sections on the theory of tunneling action; various general circuit considerations; simple switching circuits (OR gate; AND gate; MAJORITY gate; and FAN-OUT considerations); and four common digital circuits including shift register, ring counter, binary counter, and memory circuit. *Transitron Electronic Corp., Wakefield, Mass.*

High-Bay Lighting . . .

Many of the lighting problems in modern industry are discussed and analyzed in new high-bay lighting catalog. Solutions are suggested in the form of the various mercury-vapor and incandescent lighting fixtures, with each fixture being defined as to what type of problem it is designed to solve. The advantages of mercury-vapor units are compared to those of using incandescent fixtures, and points concerning venting of units, disconnecting advantages, distribution of available candle power, and types of construction are all covered in the catalog. *Thomas Industries, Inc., Benjamin Division, 207 E. Broadway, Louisville, Ky.*

Networks and Capacitors . . .

Engineering Bulletin No. 10,001 is intended to assist component and application engineers in specifying and utilizing pulse-forming networks and capacitors for radar equipment, tube testing, and similar pulse circuit applications. *Technical Literature Section, Sprague Electric Co., 321 Marshall St., North Adams, Mass.*

Universal Electronic Timing . . .

Four different applications using digital time signals to co-ordinate remote equipment in complex instrumentation and data-processing systems are described in an 18-page spiral bound brochure. Examples include: (1) airborne reconnaissance with automatic data logging, (2) ground timing system for test ranges and missile sites, (3) data processing with time compression and expansion features and (4) ground support equipment for performance checkout. System components include: digital time encoder and standard time base with seven serial and two parallel coded output signals, remote time indicators, pulse code translator, time signal analyzer, applique unit, pulse delay generator and world time standard simulator. Six types of timing wavetrain formats are illustrated. *The Hallicrafters Company, 4401 W. Fifth Avenue, Chicago 24, Ill.*

Radiation Alarm System . . .

A radiation warning system for any area where radioactive materials are stored, handled or transported is described in Bulletin GA-2. Known as the GA-2 gamma alarm system, it is a completely self-contained 12- by 15- by 8⅝-inch unit, with detector, power supply, fail-safe and alarm circuits. Wall-mounted, it operates from any 110-volt circuit. Any number of GA-2 units may be connected with simple telephone type wire into a multistation system and monitored on a central control room panel. The GA-2 is insensitive to external electromagnetic disturbances and temperature. Units are interchangeable without modification, calibration or impedance matching, and meet all AEC requirements. *Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.*

Automation for Metal Finishers . . .

A wide range of machines and equipment designed to automate metal finishing operations is described in an illustrated 29-page "Guide." Featuring photographs of actual installations, the booklet provides profit-increasing data for large or small firms contemplating automation. Entitled "When To Automate," the booklet also illustrates new types of automatic machinery currently in use by electronic firms for mass production processing of vital components. *The Meaker Company, Nutley, N. J.*

Motodrive Catalog . . .

Catalog G-100, an 88-page publication covering the complete line of Reeves Vari-Speed Motodrives, ¼ through 40 hp, is now available. Data in the catalog includes full rating tables, with new additional output speeds. Dimension diagrams and charts for more than 100 different assemblies, new higher overhung load and new controls, are also included. *Reliance Electric and Engineering Company, 24701 Euclid Ave., Cleveland 17, Ohio.*

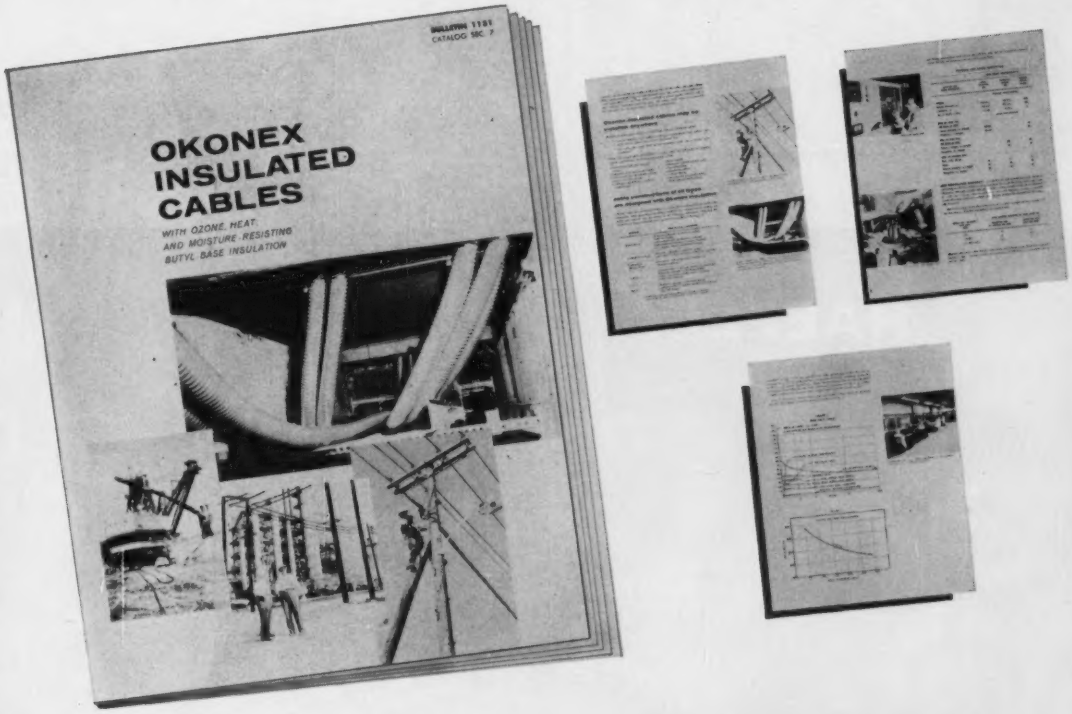
National Electrical Code Bulletin . . .

Bulletin 2722, a 60-page publication, details the applications of Condulets in hazardous locations, and discusses Code Articles 500-503 and 510-517. Product photos, installation photographs, and drawings illustrate this bulletin for use as a reference in planning electrical installations in hazardous locations. *Crouse-Hinds Company, Syracuse 1, N. Y.*

Installing a Computer System . . .

A 5-page booklet describes what to do before installing a computer system. The new booklet will enable businessmen who are planning to start computer operations to understand more fully the complexities and problems entailed in the application of a computer in their business operations. The booklet describes in nontechnical language system analysis, specifications, design, and the full operation of the computer. *Philco Corp., Computer Division, Willow Grove, Pa., Attn: Dept. N.P.*

(Continued on page 37A)



NEW! Engineering data on **OKONEX...**

Okonite's **butyl base** high voltage cable insulation

Send for a copy of this handy reference which gives complete information on OKONEX, Okonite's service-proved butyl base rubber insulation. Designed for multi-purpose service up to 90C, OKONEX is extremely resistant to ozone, heat and moisture.

You'll learn how OKONEX insulated cables can help increase load capacities in existing systems . . . how OKONEX saves you time and money in the installation of new systems . . . why Okonite's self-imposed quality control and testing specifications are your assurance of dependability in critical circuits.

This booklet contains useful technical information on current carrying capacities, dimensional data, and features illustrative descriptions on many types of cable coverings—each designed for a specific environment. Such practical information should be helpful to you in the design and specification of efficient electrical systems.

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where there's electrical power . . .

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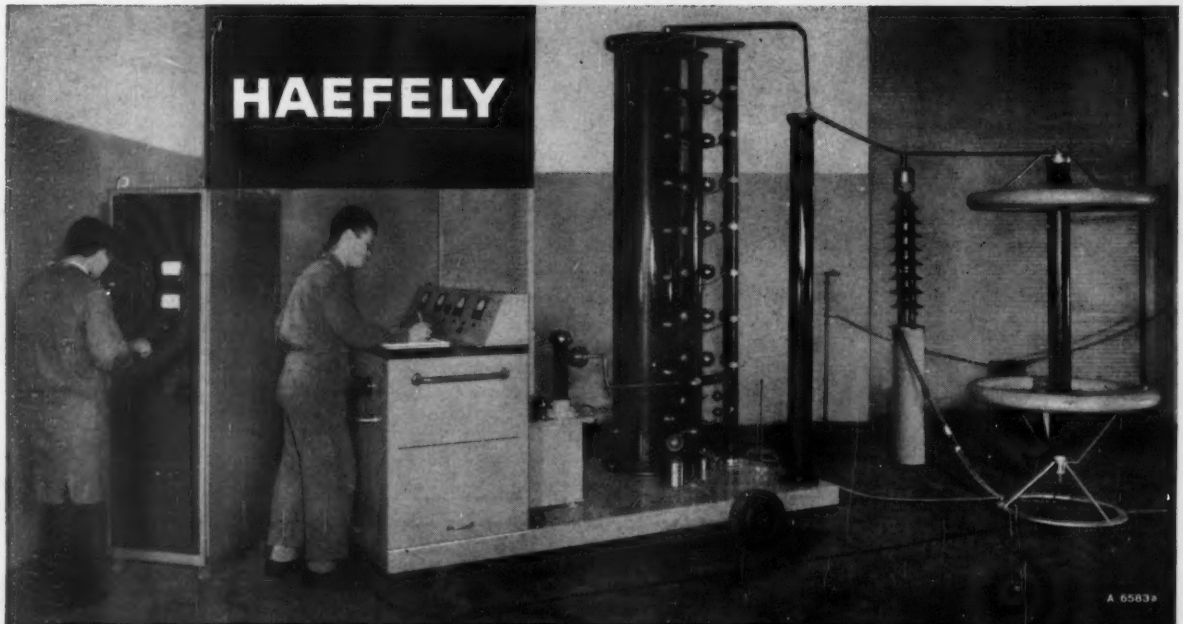

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Low inductivity of impulse circuit.
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The decade's most exciting marketing event has been annouced by the American Institute of Electrical Engineers. The 1962 Electrical Engineering Exposition is the first national exposition ever to be held concurrently with the AIEE's Winter General Meeting. It will encompass all the products and services of the electrical and electronics industries. Here's an unmatched opportunity for your company's executives to meet — and sell — the men who exert the greatest influence in the purchasing of equipment and supplies for the nation's electrical utilities, for mining and refining, for steel, metals, ceramics and general manufacturing, chemical construction, consulting, electric and electronic controls and communications and government applications.

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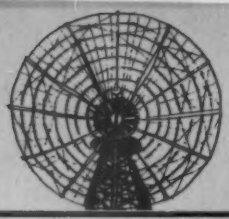

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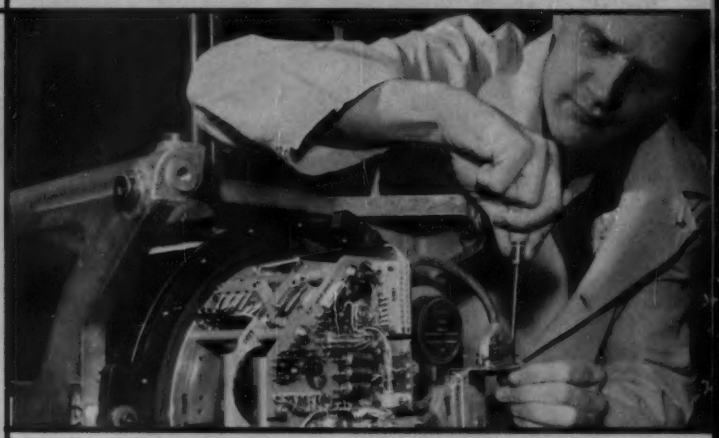
- **. . . You'll talk directly with more potential customers in a shorter time than is possible through any other sales medium.**



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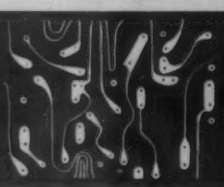

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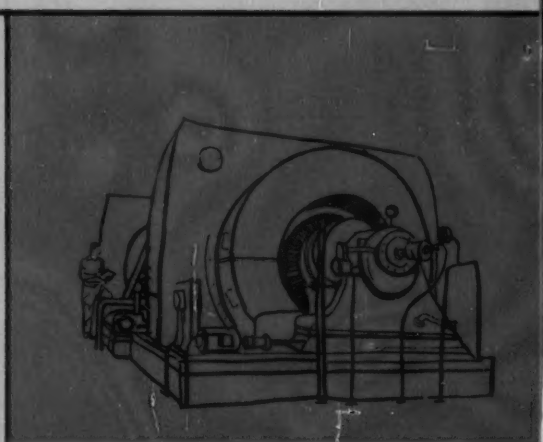


Trade Literature

(Continued from page 32A)

Heat-Resistant Castings . . .

Directions for high heat-resistant castings made in a few simple steps, and cured without catalysts, are contained in new technical bulletins on two semiflexible, single-component epoxy casting powders. The bulletins describe Maraset unfilled powder No. 135E and filled powder No. 136E, developed for encapsulating and impregnating transformers, coil windings, and other electrical and electronic components and equipment. *Marblette Corp., 37-31 30th St., Long Island City 1, N. Y.*

Synchro and Resolver Manual . . .

This 27-page illustrated technical discussion of the electrical characteristics of synchros and resolvers describes in detail the application and significance of such parameters as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. When synchros and resolvers are used in systems each of the "data-sheet properties" undergoes drastic change whose nature is thoroughly explained. Methods of measurement and the basic specifications for test equipment are also included. *Theta Instrument Corp., 520 Victor St., Saddle Brook, N.J.*

Nuclear Gauging Systems . . .

A new 4-page folder, Bulletin No. 106, describes details, method of operation, and specifications for nuclear gauging systems to be applied in the measurement of liquid, solid, or slurry levels or interfaces. Schematic diagrams show six types of applications while photographs illustrate component equipment. Other sections cover radioactive sources and source holders, detectors, zero suppression, amplifier/indicator, motor-driven gauge, and gamma switch. *The Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio.*

Electronic Measurement Systems . . .

Technical Bulletin TD-106 describes some typical instrumentation systems for jet engine test facilities, electronic methods of weight and thrust measurements and calibrations as used in ICBM facilities, and an installation at Edwards Air Force Base, designed for captive testing of all present and planned aircraft. Also discussed in the 32-page booklet are the various types of secondary standards available for force measurement as well as the reasons for the decrease in the confidence factor as the secondary standard accuracy approaches the accuracy of the primary standard. *Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.*

Piezoelectric Devices . . .

A 16-page illustrated booklet on the application of piezoelectric devices highlights new developments in high-power handling abilities of the materials. The booklet, designed to show the principal existing and potential uses of piezoelectricity, outlines and compares the performance characteristics of all major piezoelectric substances. Text and tables cover piezoelectricity as applied to convert mechanical energy to electrical energy and the reverse. Electromechanical properties and useful service temperature ranges of piezoelectric elements are also included. *Clevite Electronic Components, Bedford, Ohio.*

Nuclear Reactors . . .

The AEC has published in booklet form, a compilation of *Nuclear Reactors Built, Building, or Planned In The United States As Of December 31, 1960, (TID-8200 3rd Rev.).* The 26-page booklet contains tables listing Civilian Reactors (domestic), Military Reactors, Production Reactors, Reactors for Export, and Critical Assembly Facilities. The compilation of reactor projects and facilities is published semiannually, as of June 30 and December 31. *Office of Technical Information Extension, U.S. Atomic Energy Comm., P.O. Box 62, Oak Ridge, Tenn.*

Automatic Weight Sensing . . .

An 8-page, illustrated reference manual for the application of automatic weight sensing systems is designed as an idea stimulator to show how the principle of weight sensing, or measurement of force, can be utilized to perform a wide variety of production and quality control functions. Applications given in "Form 3513" are based on a proven weighing principle consisting essentially of a one-to-one ratio predetermined weight scale with a transducer for converting lever movement into an electrical readout signal. This signal is then available for various industrial and laboratory uses. *The Exact Weight Scale Company, Dept. "P," 920 W. Fifth Ave., Columbus 15, Ohio.*

REDUCED CORE LOSS... LESS EXCITING CURRENT WITH NEW WESCOR* CORE

New Westinghouse Wescor core combines the improvements in quality and permeability of Hipersil® steel with a newly developed method of forming a series of step-lapped core joints. Result: higher possible working inductions in the magnetic circuit. In fact, core loss is 33% less than equivalent type C core . . . with comparably lower exciting current.

Wescor cores are pretested and shipped from stock in 27 sizes, ranging from 30 to 400 pounds. More details from your nearest Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. *Trademark

You can be sure . . . if it's **Westinghouse**

J-70953

Industrial Notes...

Atlantic Research Corp.
Alexandria, Va. . .

A new Terrier ship-to-air guided missile, an improved version of the Terrier now operational with the fleet, has undergone a series of successful flight tests at the Naval Ordnance Test Station, China Lake, Calif., as announced jointly by Atlantic Research Corporation and the Navy. The fully instrumented and highly successful flights were powered by a newly developed high-performance solid-propellant sustainer motor and are considered a milestone in the rapidly advancing solid-propellant rocket technology.

Johns Hopkins University
Howard County, Md. . .

The 62-man staff of the Digital Computing Center of the Applied Physics Laboratory of The Johns Hopkins University recently moved into its new $230,000 building in Howard County, Md. The new facility is built around an IBM *7090*, high-speed digital computer. One of the first largely transistorized models, it will fulfill demands for computing services of the research and development programs of the Applied Physics Laboratory. This will include the TRANSIT navigational satellite system and advanced guided missile research. The new building of split-level design provides 8,000 square feet of space, the lower level containing the main computer room, equipment and maintenance areas, and 19 office modules. On the upper level are 6 offices and a conference area. A large viewing window is installed at the upper level from which the entire computing room operation can be observed.

Burgess Battery Co.
Freeport, Ill. . .

This division of Servel, Inc., has entered the magnetic tape market and is producing high-quality recording tapes for business, home, broadcast, and laboratory use. A separate Magnetic Tape Division has been established to handle the production and marketing of the new tape product line. Burgess audio tape is produced in ¼-inch widths and is being marketed in all standard reel lengths in seven of the most popular series.

Motorola Inc.
Scottsdale, Ariz. . .

Motorola has developed a lightweight, airborne digital computer system to be utilized as an active, real time element for the navigation, guidance, and control of drone aircraft. The work is being done by the company's Data System Laboratory, as a portion of a contract from the U.S. Army Signal Research and Development Agency. Computer functions include co-ordinate conversion, continuous and optimum data combination from multiple sources, range correction, and flight path control. Compact configuration was made possible by a fully solid-state design and unique packaging concepts. The computer is a general-purpose two address, serial, binary data type, utilizing a 12,000-rpm memory drum with a 2,048-word capacity (21-bits per word). Clock speed in the order of 260 kc permits 78 microsecond multiplication. Input-output equipment includes 0.2% D/A, a-c converters.

Hughes Aircraft Co.
Los Angeles, Calif. . .

The Hughes Microwave Tube Division is adding a building of 35,000 square feet adjacent to its headquarters to handle increasing production and development requirements. The addition will increase the division's facilities to more than 100,000 square feet. The new building will be used to house manufacturing support activities including a machine shop, tool design department, shipping and receiving, purchasing and maintenance departments.

Goodyear
Akron, Ohio . . .

In line with its expanding efforts in the field of space, Goodyear Aircraft Corporation (GAC) has announced establishment of a new aerospace department within its engineering organization. Assigned functions include management, promotion, and development of new as well as current programs, direction of mission and environment studies and establishment of forward astronautics analytical programs and systems technology requirements.

Eastman Kodak
Rochester, N. Y. . .

The company will manufacture and sell magnetic recording tape, beginning later this year. Initially, Kodak magnetic tape will be supplied for professional and amateur sound recording uses. It will be on triacetate base and packaged in rolls ¼ inch wide in standard lengths. Sale of tape for home-recording uses will be through Kodak's regular distribution organization of established photographic dealers.

North American Aviation, Inc.
Los Angeles, Calif. . .

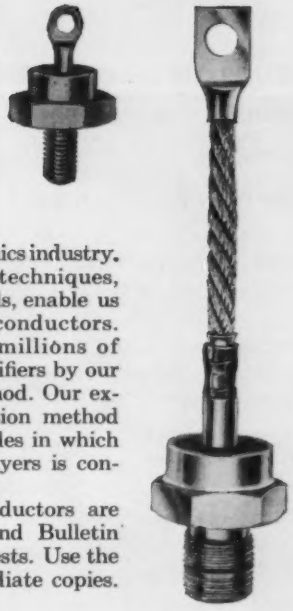
A metal-cutting machine guided by perforations in an endless tape has finished its 84th aluminum wing skin for North American Aviation's T-39 Sabreliner. The machine is one of a dozen controlled by numbers punched on tape now in operation at North American's Los Angeles division. Similar machines, all owned by the Air Force, are also used at other company divisions.

American Electric Power
New York, N. Y. . .

The American Electric Power (AEP) System has announced plans to construct four major transmission lines utilizing guyed towers made of aluminum. It will be the first utilization of guyed aluminum towers in the United States. The four 138,000-volt lines will total 100 miles and will tie two power projects now under construction into the balance of the AEP System. They will call for the use of approximately 800,000 pounds of structural aluminum shapes of various kinds. Two lines will be built from the Smith Mountain hydroelectric project of Appalachian Power Company, on the Roanoke River 46 miles southeast of Roanoke. The other two lines will begin at the Big Sandy Plant of Kentucky Power Company at Louisa, Ky. The tower design, a V-shaped structure with a single compression foundation and four guy anchors, is similar to designs used in Finland and Sweden which rely entirely on stranded guy wires for support.

(Continued on page 40A)

You are looking at the semiconductor industry's first *guaranteed and* certified rectifiers



Here is the most sweeping assurance ever offered on the reliability of complete standard lines of silicon and selenium rectifiers.

Every Syntron Semiconductor is certified to have passed a specific program of tests and inspections (spelled out in the Certification, below)—and is *guaranteed* to perform to these certified levels for 18 months after shipment!

The savings to manufacturers in minimizing their own incoming tests and inspections are obvious. Designers now can specify rectifiers tested to standards which match those of virtually any mass manufactured product in the electronics industry.

Exclusive manufacturing techniques, plus rigid quality control levels, enable us to introduce Certified Semiconductors. Every month we produce millions of square inches of selenium rectifiers by our unique vapor deposition method. Our exclusive gaseous double diffusion method produces identical silicon diodes in which the depth of the P and N layers is controlled to a very few microns.

Syntron Certified Semiconductors are described in Catalog 100, and Bulletin 200 details the Certification tests. Use the coupon below for your immediate copies.

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All Syntron semiconductors have been tested and inspected to AQL level of 1.0, Inspection Level II, and are so certified. Electrical and mechanical tests include:

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- Forward drop at rated current and a diode or cell temperature of 25°C.
- Testing of all rectifier assemblies at rated load conditions.

We guarantee that our semiconductors will meet their certified AQL performance levels for up to 18 months after shipment provided they are not misused or misapplied. All Syntron semiconductors found to be defective in materials or workmanship will be replaced at no charge upon return to our plant.

SYNTRON COMPANY, Semiconductor Div., Dept. EE-2, Homer City, Pa.

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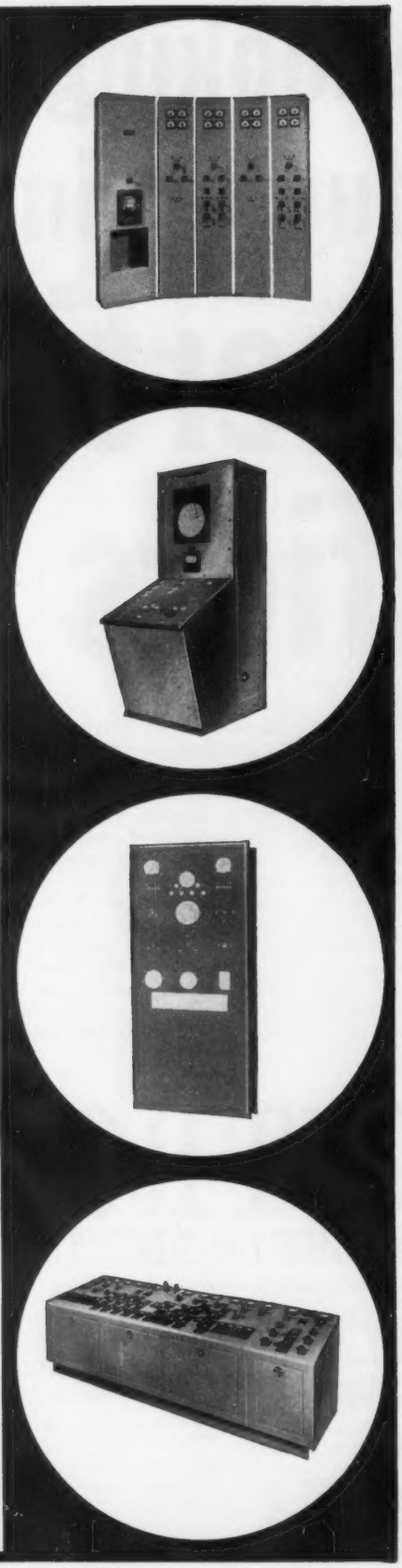


Industrial Notes

(Continued from page 38A)

Food Machinery & Chemical Corp. New York, N. Y. . .

Reinforced plastic parts are helping insure high performance in the *RP-76* rocket-powered target missile employed by the U. S. Army to test its surface-to-air weapons systems. This missile-plastic application was featured in a recent exhibit by Food Machinery and Chemical Corporation. The drone's plastic nose and aft fuselage sections give lightweight strength that helps make ground recovery possible when the target is not intercepted in flight. Molded from glass cloth (prepregs) impregnated with Dapon diallyl phthalate resin, the parts are attached to the steel case housing the solid-propellent rocket engine. The plastic parts also provide unusual weathering protection and resistance to the extreme temperatures (above 200 F) encountered at supersonic speeds. Outstanding electrical properties make the plastic material transparent to radar beams, thus permitting unobstructed reflections from the Luneberg radar augmenter installed in the nose of the drone.

General Precision Equipment Tarrytown, N. Y. . .

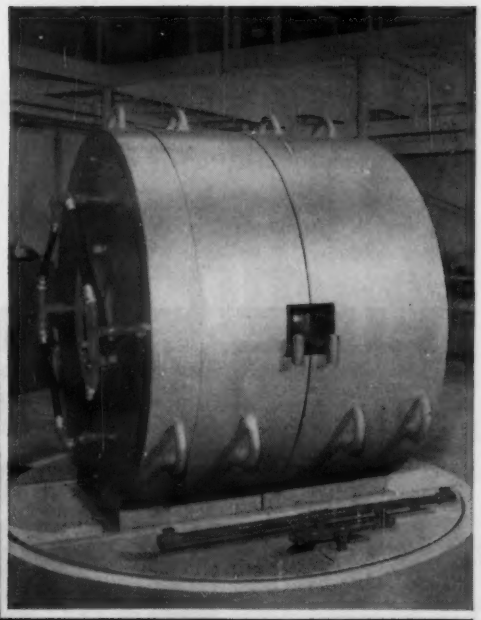
General Precision Equipment Corp. (GPE) has moved into its new corporate headquarters in suburban Tarrytown, N. Y. The newly constructed, 2-story, 40,000-square-foot building also provides headquarters and needed expansion facilities for the company's electronic subsidiary, General Precision, Inc. In addition, the new location will house management and staff of National Theatre Supply Company, another GPE subsidiary.

Allis-Chalmers Mfg. Milwaukee, Wis. . .

The company has been named the principal supplier for equipment for a multimillion dollar irrigation project to be constructed north of Sacramento, Calif., for the Oroville-Wyandotte Irrigation District. Object of the project is to control the watershed for irrigation in the south fork of the Feather River, while providing hydroelectric power generation at key dams along the system. Power generated will total nearly 100,000 kw. Allis-Chalmers has unit responsibility for the power generation, transmission, and system control package, including hydraulic turbines, generators, power transformers, switchgear, controls, and communication equipment.

(Continued on page 42A)

National builds magnet coils for Ohio State's low temperature research



The magnet in which these National coils are used works with a cryostat to develop temperatures approaching –460°F. The Ohio State University will employ the equipment to study the behavior of solid materials in the temperature range between 1/100 and 1 degree above absolute zero.

With a liquid refrigerant, the lowest temperature that can be reached is 0.4° absolute. With electromagnetic cooling, researchers will be able to attain temperatures as low as 0.01° absolute, opening up new fields of scientific knowledge.

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Industrial Notes

(Continued from page 40A)

Fairfield Controls, Inc. Stamford, Conn. . .

Fairfield Engineering Corp. of Connecticut and Fairfield Controls, Inc. of Delaware have merged to form Fairfield Controls, Inc., with the main office and manufacturing facilities in Stamford, Conn. The company will continue to develop products for the power control field by devoting itself to the design and manufacture of solid-state power switching devices, servo amplifiers, motor speed controls and temperature controls.

American Enka Corp. Concord, Mass. . .

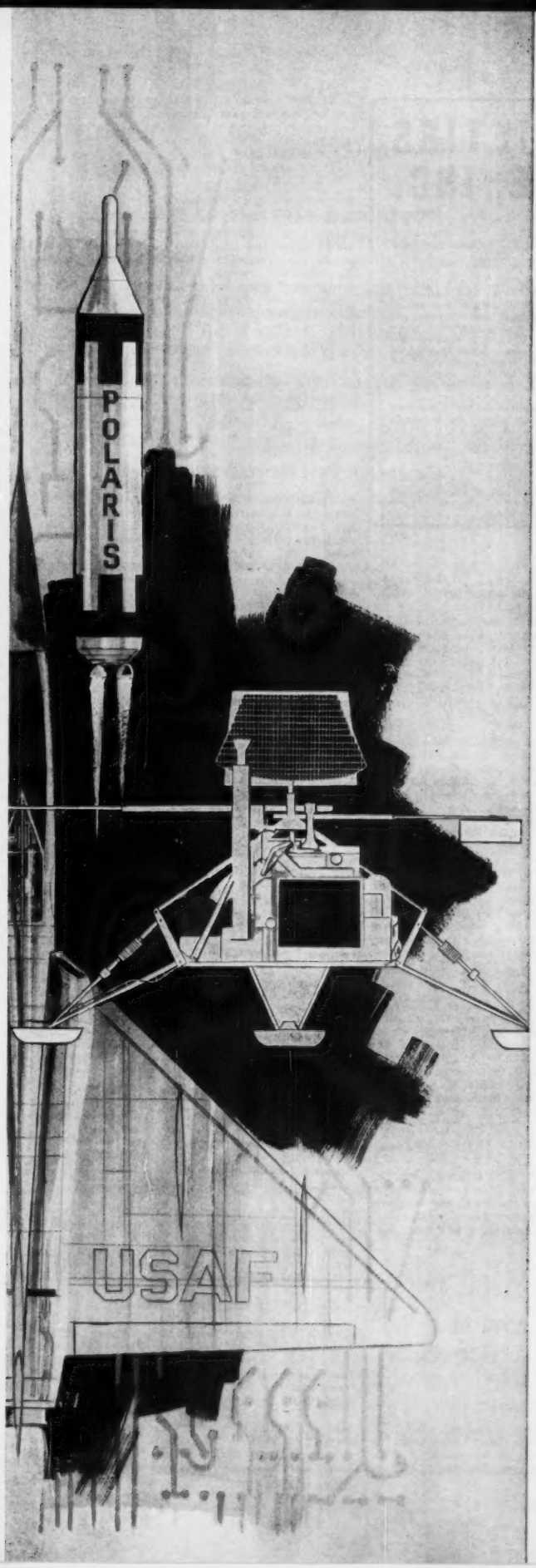
The Brand-Rex Division of American Enka Corp. has announced a major expansion of production facilities in California. A new 40,000-square-foot plant is being established in Gardena

to manufacture a broad range of military and commercial wires and cables. The capabilities for cabling and cold process jacketing presently housed in the existing Santa Monica plant will be transferred to Gardena, where they will be fully integrated into newly created production operations. These include the primary insulation of conductors, striping, braiding and shielding, and the extrusion of cable jackets.

Atomic Energy Commission Washington, D. C. . .

The Atomic Energy Commission will build a reactor experiment at the Commission's national reactor testing station in Idaho which will provide data on the use of gas-cooled reactors for maritime and other civilian power applications. The work will be performed by the General Atomic Division of the General Dynamics Corporation as part of its assignment under the Commission's program to develop a closed cycle, gas turbine marine propulsion plant powered by a high-temperature, helium-cooled, beryllium oxide-moderated reactor. The reactor will be fueled with a mixture of uranium oxide and beryllium oxide.

(Continued on page 45A)



Opportunities for

circuit designers

Requirements of new and continuing projects, such as Surveyor and supersonic interceptor fire control systems have created new openings for circuit designers. The engineers selected for these positions will be assigned to the following design tasks:

1 the development of high power airborne radar transmitters, the design of which involves use of the most advanced components,

2 the design of low noise radar receivers using parametric amplifiers, solid state masers and other advanced microwave components,

3 radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits,

4 high efficiency power supplies for airborne and space electronic systems,

5 telemetering and command circuits for space vehicles such as Surveyor and the Hughes Communication Satellite,

6 timing, control and display circuits for the Hughes COLIDAR* (Coherent Light Detection and Ranging).

In addition, openings exist for several experienced systems engineers capable of analysis and synthesis of systems involving the type of circuits and components described above.

If you are interested and believe that you can contribute, please airmail your resume to: **Mr. Robert A. Martin,** Supervisor, Scientific Employment, Hughes Aerospace Engineering Division, Culver City 34, California.

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If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

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PROFESSOR OF ELECTRICAL ENGINEERING OR ELECTRICAL OR MECHANICAL ENGINEER, E.E. Degree, M.E.E. Public Utility, seven years'; teaching electrical, math., mechanical, 23 years'; E.E. (General) N.Y. Naval Shipyard, five years', plus consulting. Salary, $12,500. Location, East. E-241. (Walter La Pierre).

MANUFACTURING EXECUTIVE, Engineering Graduate. Over 20 years' experience in factory, sales, consumer and liaison, production engineering, quality control, purchasing, cost control, plant layout, supervisory training, cost reduction, production control, product development, methods improvement. Salary, $11,000-$12,500. E-242.

Chicago Office

MILL ENGINEER, B.S.E.E., 34. 13 years' varied experience in electrical power and controls including four years' paper mill. Desires challenging and responsible position in paper or related industry. Salary and location secondary to advancement potential. E-2138-Chicago.

SALES MANAGER, B.S.E.E., 36. Wide experience in application and sales of electrical components and process control equipment to OEM's, distributors and other industrial users. Presently working for MBA degree in marketing. Salary, $10,000-$12,000 a year. Location, Chicago. E-2139-Chicago.

CHIEF ENGINEER OR SUPERVISOR, B.S.M.E., plus some post graduate, 36. Broad knowledge of operation and maintenance of industrial electrical and mechanical equipment. Supervisory experience of electrical department of fifty men. Trouble-shooting and managerial reports. Salary, $10,000 a year. Location, anywhere within reason. E-2140-Chicago.

CHIEF ENGINEER, B.S.E.E., Power Option, 42. 13 years' experience design of power, distribution, instrument, street lighting transformers; three and a half years' design group leader, supervisory capacity, executive assistant; computer program planning. Salary, $10,000 a year. Location, South, Southwest, Midwest (not deep south). E-2141-Chicago.

SALES MANAGEMENT, B.S., plus Legal, 47. Twenty four years' of sales and management experience in fields of metal working and automotive industry. I offer a successful record of sales management including the development of winning teams. Salary, $20,000. Location, U.S.A. and Europe. E-2142-Chicago.

OPERATIONS MANAGER, B.S. in E.E., Professional Engineer, 44. 23 years' transmission and distribution design, construction, maintenance, operation and associated service functions. Good record customer employee relations. Foreign and Domestic experience. Presently located in Brazil. Available for interviews in U.S. in July or August, 1961. Salary, $15,000 a year. Location, U.S. or Caribbean. E-2143-Chicago.

ELECTRICAL DESIGN ENGINEER, B.S. in E.E., 1941, 42. Ten years' outdoor substation layout and design for public utilities—distribution; subtransmission; power plant substations. Salary, $8400 a year. Location, Midwest preferred. E-2144-Chicago.

POSITIONS AVAILABLE

New York Office

ENGINEERS. (a) Senior Engineer, B.S.E.E., with a minimum of three years' experience in AC induction motor design, hp rating 5 0 to 2,000 fractional hp will be considered. Salary, to $12,000 a year. (c) Senior Engineer, B.S.E.E. and/or B.S.M.E. for the design of fluid flow and pumping systems. Circuitry design for automatic programming of control rod drives and position indicating devices. Salary to $14,400 a year. Location, Pennsylvania. W200.

MAINTENANCE ENGINEER, graduate mechanical or electrical, to 40, experienced in maintenance and evaluation of the operation of large housing projects. Estimate heating, plumbing, electrical systems, costs, for repair and improvement. Prepare specifications and write reports. Some travel through N.Y., N.J., and New England. Salary, $9000 a year. Headquarters, New York City. W219.

CONSULTING ENGINEER, mechanical, electrical, and electronics graduate, for surveillance of the design, procurement and installation of power plant machinery, valves, etc. Must be U.S. citizen. Open. Headquarters, New York City. W193.

ELECTRICAL INSTRUMENT ENGINEER, graduate in electrical engineering, with three to five years' experience in maintenance and operation of large, high voltage switchgear and motors and process control instrumentation. Duties will include providing technical knowledge and assistance in the maintenance and modification of plant electrical equipment and process control instrumentation. Salary, $8400 a year. Location, East Coast of Florida. W188.

TEACHING PERSONNEL for electrical engineering department. (a) One to teach in the area of circuit analysis, linear system analysis, digital computers and electrical measurements. Teaching mainly at the undergraduate level. (b) One to teach in the area of feedback control systems, industrial electronics, communications and high frequency electronics. Teaching mainly at undergraduate level. Ranks and salaries dependent upon qualifications. Location, Canada. W186.

SALES APPLICATION ENGINEERS, graduate electrical, 28-38, with a knowledge of semiconductor circuits with respect to circuit function, circuit design and component application. Some knowledge of experience in systems with ability to reduce a flow diagram into types of specific circuits to accomplish the end result indicated in the flow diagram. Should be sales oriented. Training period of several months before assignment to the field. Must be willing to travel, possibly 50% of time. Salary plus fixed commission. Territories: One for West Coast; the other for Midwest or East Coast. Headquarters, Pennsylvania. W184.

ELECTRONIC ENGINEERS, graduate electrical, with electronic circuit design experience, for work involving the modification of existing circuits, the design and development of new magnetic and pulse circuits in the general field of memory devices. Salary, $8000-$9000 a year. Location, central Pennsylvania. W183.

TRANSFORMER ENGINEER with experience in the design and development of hi-frequency and pulse transformers for commercial and military applications. Excellent opportunity. Salary open. Location, Pennsylvania. W182.

ENGINEERS. (a) Head of Department, Electrical Engineering. Must have Ph.D. Will also teach graduate and post graduate students electrical engineering. Salary, $11,000-$12,000 for nine months. (b) Associate Director, Ph.D. in mechanical, electrical, or chemical engineering, to head up experimental research station. Salary, to $12,000 a year. (c) Associate or Assistant Professor, young, Ph.D. or Master's in electrical engineering. Salary open. Location, South. W175.

Wiley BOOKS

Stanley: **THE CONSULTING ENGINEER**

Deals incisively with internal problems in the engineer's practice and with his professional relations with clients. 1961. 258 pages. $5.95

Meyerhoff (editor): **DIGITAL APPLICATIONS OF MAGNETIC DEVICES**

The only single-volume introduction. Covers electrical, logical, and system design for developing digital systems using the toroidal magnet or magnetic core as the basic circuit element. 1960. 604 pages. $14.00

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Includes details on supervising installation, operating instructions for existing equipment, maintenance procedures. 1960. 424 pages. $9.50

Kingery: **INTRODUCTION TO CERAMICS**

A pioneering book—general in conception and based on a rational approach to ceramic phenomena and properties—densification during firing, strength, etc. 1960. 781 pages. $15.00

Polydoroff: **HIGH-FREQUENCY MAGNETIC MATERIALS**

The first comprehensive guide to ferromagnetic materials and their applications. Includes tests, measurements, examples. 1960. 220 pages. $9.00

Heumann: **MAGNETIC CONTROL OF INDUSTRIAL MOTORS, 3 vols.**

Controllers for industrial A-C and D-C motors are carefully analyzed, and each type of motor is granted full treatment in conjunction with its associated controllers. **Part I:** A-C Control Devices and Assemblies. 1961. Approx. 312 pages. Prob. $8.00. **Part II:** A-C Motor Controllers. 1961. Approx. 368 pages. Prob. $9.00. **Part III:** D-C Motor Controllers. In press.

Puchstein: **DESIGN OF SMALL DIRECT-CURRENT MOTORS**

Presents in detail methods for solving problems of calculation and design. Includes techniques for cases in which parts are available and for design from the ground up. 1961. 407 pages. $12.00

Gibson-Burgess-Kroger (editors): **PROGRESS IN SEMICONDUCTORS, Vol. V**

Properties of semiconductor surfaces; absorption edge spectra; chemical bond; thermal conductivity; indium antimonide; magnetic-optical phenomena; band structure and electronic properties of graphite crystals. 1961. 316 pages. $11.00

Bulloff-Peet (editors): **SEMICONDUCTOR ABSTRACTS: Vol. VI, 1958 Issue**

Latest in the Battelle-Electrochemical Society series. Recent developments in semiconducting and luminescent materials, plus references to applications of electronic processes in solids. 1961. 528 pages. $14.00

Birks (editor): **PROGRESS IN DIELECTRICS, Vol. III**

One of a series covering the entire range of newer dielectric materials. 1961. In press. **Vol. I,** 1959. 312 pages. $11.00. **Vol. II,** 1960. 225 pages. $9.50

Wiener: **CYBERNETICS, Second Edition**

A thorough revision and expansion of one of the most important scientific works produced in this century. An M.I.T. Press book. 1961. In press. Prob. $6.00

Wozencraft-Reiffen: **SEQUENTIAL DECODING**

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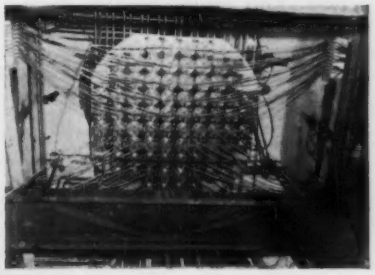
Industrial Notes

(Continued from page 42A)

Columbus Die, Tool & Machine Co. Columbus, Ohio . . .

The Columbus Die, Tool and Machine Company supplied the thimble locating plate for the atomic reactor at Commonwealth Edison's Dresden Nuclear Power Station. The thimble locating plate, located at the bottom of the reactor vessel, contains 80 precision-placed holes. Each hole aligns a



flange of a thimble which holds a control rod in line with the bottom of the reactor core. The part accurately guides the control rods into and out of the reactor core, controlling the rate of the chain reaction. When inserted into the core, the rods, each containing 2% boron, absorb neutrons and cut down reactor reactivity. When withdrawn, they permit increased reactivity. The 300-ton reactor pressure vessel in which fissioning takes place is located in the center of a giant 190-foot steel sphere. The thimble locating plate is circular in shape, with a 9-foot diameter, and is made of 1½-inch thick steel plate.

RCA Victor Edmonton, Canada . . .

Arrangements have been completed for the building and installation of the most powerful low-band television transmitter in North America at the Canadian Broadcasting Corporation's new station CBXT-TV, in Edmonton. The new CBC transmitter is said to be capable of broadcasting with an effective radiated power of 318 kw, which is almost double that of any low-band station (covering channels 2 to 6) in Canada and three times as powerful as any in the United States. While signal power of low-band transmitters is limited by international agreement to 100 kw within 250 miles of the Canada-United States border, Edmonton, by its geographical location, avoids this ruling, and the CBC is using the increased power to give exceptionally wide coverage.

(Continued on page 47A)

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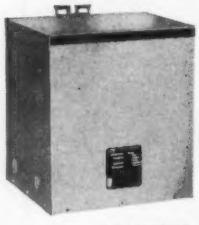

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1. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers in Business and Industrial Systems), Nov. 7-9, 1955, Boston, Mass.

   Sponsors: The Association for Computing Machinery, AIEE, The Institute of Radio Engineers.

   100 pages, 15 papers and discussions. Price: $3.00.

2. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers with Deadlines to Meet), Dec. 9-13, 1957, Washington, D.C.

   Sponsors: The Institute of Radio Engineers, The Association for Computing Machinery, AIEE

   259 pages, 48 papers and discussions. Price: $3.00.

3. **PROCEEDINGS OF THE WESTERN JOINT COMPUTER CONFERENCE,** Feb. 26-28, 1957, Los Angeles, Calif.

   Sponsors: The Institute of Radio Engineers, AIEE, The Association for Computing Machinery

   240 pages, 37 papers and discussions. Price: $4.00.

4. **PROCEEDINGS 1957 ELECTRONICS COMPONENTS SYMPOSIUM,** May 1-3, 1957, Chicago, Ill.

   Sponsors: AIEE, The Institute of Radio Engineers, Radio-Electronics-Television Manufacturers Association, West Coast Electronic Manufacturers Association; also Agencies of the U. S. Department of Defense, and the National Bureau of Standards

   282 pages, 43 papers. Price: $5.00.

5. **1958 NATIONAL TELEMETERING CONFERENCE,** June 2-4, 1958, Baltimore, Md.

   Sponsors: Institute of Aeronautical Sciences, AIEE, Instrument Society of America, American Rocket Society

   317 pages, 63 papers and abstracts. Price: $4.00.

6. **NONLINEAR MAGNETICS & MAGNETIC AMPLIFIERS PROCEEDINGS,** Aug. 6-8, 1958, Los Angeles, Calif.

   Sponsors: AIEE, The Institute of Radio Engineers, The Instrument Society of America

   482 pages, 30 papers. Price: $7.00.

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New York 18, N. Y.

Industrial Notes

(Continued from page 45A)

Westinghouse Pittsburgh, Pa. . .

The first of 13 waterwheel generators made by the Westinghouse Electric Corporation began producing power recently at the western world's largest power project. The New York State Power Authority's Niagara Power Project, with a capacity of 2,190,000 kw, was the scene of a colorful first-power ceremony just 3 years from the start of construction. The generators have a rating of 150,000 kw each. Each generator weighs 1,094 tons and is 40 feet in diameter. The rotor, weighing 590 tons, is driven at 120 rpm by a shaft weighing 56 tons and measuring more than 4 feet in diameter. Westinghouse completed the manufacture of the 13th generator at its East Pittsburgh, Pa., plant in January. The generators are being installed at the rate of one every 35 days. The 13th and final generator is scheduled for installation in the Robert Moses Niagara Power Plant in April 1962.

Royal Industries Los Angeles, Calif. . .

With the acquisition of Dublin Industries, Inc., of Hayward, Calif., Royal Industries, Inc., has expanded its activities in the nuclear field. A company engaged in nuclear research and analysis, Dublin will be operated as a subsidiary of Royal Industries under the name Royal Research Corporation.

Applied Electronics Corp. Metuchen, N. J. . .

One of the tiniest radio telemeters ever used in air-to-ground missile control provided vital data on the flight performance of the Minuteman missile launched from Cape Canaveral. The miniaturized telemeter, installed in the nose cone of the ICBM was developed by the Applied Electronics Corporation of N.J. on a subcontract from Avco, producer of the nose cone. The telemeter's operation in the Minuteman was based on the in-flight transmission of a radio signal from the nose cone containing a large number of information channels relating to the conditions both inside and outside the missile. This information was picked up by specially designed ground antennas, transmitted on a single radio channel through receivers and finally broken down into specific channels of information. Each one of these channels fed into a device which recorded its data on a magnetic tape.

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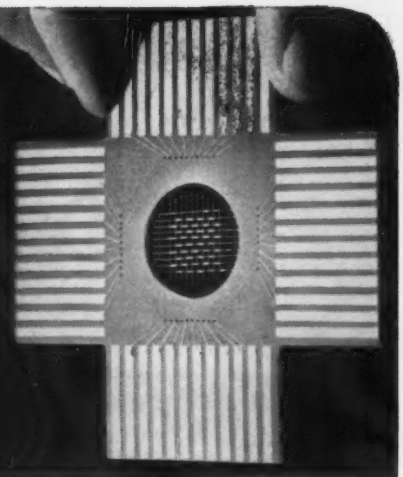

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We prefer a man with 5 to 10 years' experience and one who enjoys travel and contact with other engineers.

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If interested and qualified, please forward your resume to Mr. J. E. Goode, Assistant Chief Engineer, P. O. Box 748E, Fort Worth, Texas.

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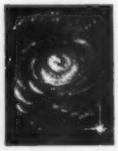

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March 1959

This conference was planned to provide a review of the progress made in instrumentation technology. Publication T-113 is the record of the conference held at Philadelphia, Pa., April 20-21, 1959. Sponsored by the Recording and Controlling Instrumentation Committee of the AIEE, the 279-page publication contains 31 of the papers presented at the meeting which was divided into the following sessions:

1. Engineering Education for Instrumentation
2. Electronic Analog Recorders
3. Computer Control Systems
4. Data Handling Systems for Industrial Processes
5. Electrical Transducer Systems for Electrical Control
6. High Speed Data Handling and Processing
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Publication T-113 may be ordered for $5.00 from the

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FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

Industrial regulators
Tracer machine tools
Process control
Nucleonics
Aircraft engines
Flight path control
Fire control
Platform stabilization
Flight simulators
Computers
Test equipment
Magnetic Amplifiers
Potentiometers
Gears and dampers

The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and nonmembers from the Order Department

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Telemetering Supervisory Systems and Associated Channels

This revised report (Vol. 1, Parts 1, 2, and 3) was prepared by subcommittees of the AIEE Committee on Telemetering in the Instrumentation Division and is intended as a guide to technical information in the telemetering field, including stationary or point-to-point telemetering, mobile telemetering, etc.

Part 1 is on Telemetering, Part 2 is on Supervisory Systems, and Part 3 is a numbered bibliography starting prior to 1920 up to 1958. At the end of the bibliography is an alphabetical listing of authors by number.

The 71-page booklet, S-111, is available for $2.50 from

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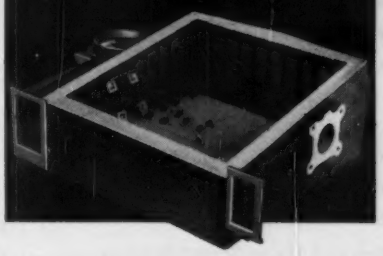
Environmental conditioning *for fire control systems*



AiResearch integrated environmental conditioning of aircraft fire control systems achieves high effectiveness while reducing space and weight requirements.

Representative of AiResearch progress is this air-to-air environmental conditioning package which uses the integral heat exchanger and cold plate cooling unit as the base and mounting frame of the pressurized enclosure for the fire control system transmitter. Net weight of this unit is 9.5 lb. with a heat rejection of 425 watts.

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another AIEE publication

Third Report on Survey of Electric Utility Applications of Digital Computers

This listing and description of electric utility applications of digital computers is a revision of AIEE Special Publication S-109. Included are solicited contributions from privately owned and publicly owned utility systems having more than 75,000 custom meters.

Presented at the AIEE Winter General Meeting, New York, N.Y., January 29—February 3, 1961.

Prepared by AIEE Computer Application Subcommittee of the AIEE System Engineering Committee.

Send $2.50 for S-109-A to

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Symposium on Research and Education

Special Publication S-82 comprises of four papers that were presented at the AIEE Winter General Meeting, New York, N. Y., February 2, 1956, and is sponsored by the AIEE Committee on Research and Education. The papers deal mainly with the problems of the utilities and the industry in general in attracting young engineers into the field.

The price is $1.60 ($0.80 to AIEE members). Available from:

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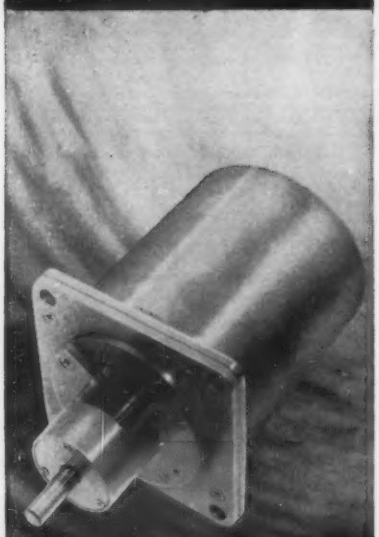

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Power Supply for Resistance Welding Machines
(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940-1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

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THERMAL EVALUATION OF INSULATING MATERIALS
(June 1954)

At the 1954 Winter General Meeting the Subcommittee on Dielectrics and its Working Group sponsored three sessions of papers covering various phases of the problem of evaluating insulating materials. Since these papers review much of the recently developed information on this subject, it was decided to reprint them in this form. As test methods on the thermal evaluation of insulating materials become available, more and more data on thermal stability of both the newer and the older materials should develop, and eventually make possible the rational revision of AIEE Standard Number 1 on a sound basis.

The 72-page printed publication contains 16 papers and discussions, presented at the 1954 AIEE Winter General Meeting.

Publication S-61 is available at the price of $1.50 to members and nonmembers. Send orders to:

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716-CS1 Capacitance Bridge $600 (rack model, $575)	0.5 to 3 Mc	C: 0.1 to 1150 μμf D: 0.00002 to 0.56	±0.2% ±0.2%

Instrument	Measurement Frequencies	Range of Measurements	Basic Accuracy
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